THE POWER EXECUTIVE

FOR THOSE WHO MANAGE POWER PLANTS

POWER'S chief service to its readers is its month-by-month presentation of a great variety of practical information on the engineering details of plant design and operation. But this is not enough. From time to time certain aspects of the power job call for intensive treatment.

That time has arrived again. Today every power executive faces a world of responsibilities that won't stay put in little technical niches. More than ever, technical knowledge is expected of him, but on top of this he must be a man of infinite resourcefulness in dealing with problems hardly mentioned in engineering books.

Human relations demand constant attention. Wages, working conditions, individual responsibilities and capacities, training, conferences with other executives—all these are daily problems.

Cost records become more and more important. Maintenance calls for more systematic planning. Problems of investment, savings and net profits demand wise solution at the very moment when factory departments are crying for some new variety of service or asking technical help on some knotty processing experiment. Daily annoyances hamper quiet thinking, but long-term planning must go on.

Beyond any question, it's a job that calls for stamina and brains, for real executive ability to match difficult executive responsibilities. It calls also for long experience —one's own and that of other engineers who have been through the mill.

Hence *Power* is doing no more than its job in presenting here twelve pages on Power Management. Five plant executives of tested ability (see page 674) get down to brass tacks on managerial problems. The editor has a word to say about planning for growth and change. Eleven well-known engineers give the essence of their power philosophies.

From all this we sincerely hope that many readers, whether now power executives, or executives to be, will draw ideas that can be cashed in for prestige, accomplishment and higher salary checks.

THE POWER EXECUTIVE

RESPONSIBILITIES AND MEN

By F. M. GIBSON
Plant Engineer,
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Surveyed in a single article, the responsibilities of the power engineer are staggering in their complexity. But engineers of experience do this job and do it well by knowing their machines and their men.

TOO few plant engineers take time to develop a comprehensive picture of their duties as power engineers. Time devoted to a study of that kind might avoid the type of embarrassment suffered by a manager who stated that affairs had been so hectic for a period of three years as to prevent a vacation. The superior officer to whom the statement was made immediately asked if it was a case of being too busy or of lacking executive ability. That manager soon had a vacation (not forced).

One effective way to get the panoramic view is to write an article such as this, even though it is not for publication. Writing develops viewpoints that are most illuminating, as this author can attest. Another way is to make a check list such as that made by David Moffat Myers for building new power plants.

I am to discuss, first, *responsibilities;* second, *men.* The most immediate responsibility is continuity of service—of heat, light, power, hot and cold water, injection water, compressed air, refrigeration. Unlike the central station engineer, the industrial power engineer must transmit and apply these commodities. In self-protection, he must study the extent of periodical inspections, cleanings and adjustments; he must watch pressure and temperature charts to spot insidious changes. A smooth-working system must insure a ready supply of tools, repair parts and materials to cope with breakdowns. Operatives must be instructed in emergency procedure.

Careful study is necessary to select fuels, feedwater treatments and lubricating oils which will not endanger operation. Erosion, corrosion, embrittlement and fatigue of metals must be considered. Where necessary, conditions must be corrected or more resistant metals substituted. Dangerous overload, as well as excessive heat, dust and moisture, must be recognized and corrected. The cost of breakdowns must be estimated in advance in order to determine how much investment is justified to prevent them.

Increasing power loads and constant improvements in heat economy challenge the ingenuity of the power engineer. He must master his heat balance. Before investing large sums for higher throttle pressures and lower exhaust pressures, the less expensive correctives must be studied. The trick may be turned by changing auxiliary drives so that turbines exhaust into the higher process pressure system, or by installing a small power unit to reduce waste of exhaust steam when processes are not operating. Elimination of peak loads, correction of power factor and more economical application of power are also direct responsibilities.

Much power can be saved by a study of process materials. Pump loads may be lowered by studying the viscosity of the materials pumped—by preheating or sizing materials before processing. Oftentimes, operating temperatures and pressures have been set up to meet some emergency and have remained unnoticed after the emergency has passed. In checking these conditions it is often found that some processing done by high-pressure steam can be done equally well with exhaust steam if heating surface is increased.

The responsibility for generating power and heat more cheaply rests squarely on the shoulders of the plant engineer. He must investigate the possible use of central station heat and power. He must study available fuels, including waste products, to determine whether alterations to existing equipment will permit the use of cheaper fuels or create a buyers' market by his ability to select from a wider range of fuels. Replacement of equipment for higher efficiency, lower maintenance costs, reduced hazards, or greater continuity of service must be considered.

Measure Power Costs

Yet the benefits of replacement cannot be estimated without dependable records of performance and cost. In the cost-accounting of power-service generation, no one but the engineer can lay out the system or correctly allocate costs to consuming departments.

The best way to reduce consumption is to meter the services used by individual departments and advise the department heads of the costs. When accurate service costs are set up as a dependable gage of performance the department head will automatically seek the engineer's aid in bettering it. The engineer is also responsible for selecting new equipment that will be in line with the ultimate design of the plant.

An important obligation is the determination of economical recovery of heat from flue gases, finished product, waste water and other waste materials. Great economies are sometimes possible through elimination of re-evaporation, installation of multiple-effect evaporators, improved circulation or agitation of process materials and changes in process due to changes in temperature or pressure.

The engineer must contact municipal, state, federal and underwriters' boards on such subjects as labor, licenses, construction, pollution, accident, fire and explosion hazards and sanitation. The question of budgets is always alive. There is the problem of whether the power department shall have its own maintenance crew or depend upon the plant mechanics and whether jurisdiction over the application of heat and power in the factory shall come under the power engineer or the production engineer.

Handling Yourself

Now how about handling men? Let me answer with another question, "Which Men?." The first man who must be managed by the plant engineer is himself. In getting a line on himself he cannot afford to be unduly optimistic, pessimistic or biased. He must know definitely whether his knowledge of each engineering specialty is real or just a vocabulary, in order to determine when to depend upon himself and when to consult outside authorities.

To meet his wide range of responsibilities he must not only have a broad engineering knowledge, but must also know the dependable sources of knowledge that he does not possess. To accomplish this, every plant engineer should re-invest a definite portion of his time and income in his profession, just as an intelligent business man puts part of his profits back into his business. Good investments can be found in a carefully selected reference library, proceedings of technical societies and subscriptions to technical magazines, yet there is much helpful information not to be found in print, obtainable only through contact with other engineers.

Such contacts are easily made by attending meetings, by serving on committees, by organizing local groups of plant engineers, by visiting other plants. If the engineer hopes to receive dependable and accurate information he must be willing to give likewise.

Much is said and written on the subject of handling men, but it usually consists of advice on how to treat the man *below*. The power engineer can best fulfill his obligation to his employer when he clearly understands the motives and character of the executive superior from whom he gets the most accurate information of factory conditions and problems. Such an understanding is necessary in giving requested advice on steam and power; it is equally helpful when the engineer has to *sell* himself or his ideas.

Here the engineer must consider all of the attributes of a good salesman, such as merit of proposition, clearness, brevity, personality and appearance. The engineer must study his executive as a sales prospect: To what kind of argument is he most susceptible? What type of proposal or report does he appreciate most? Some executives desire only the major arguments, others want all of the arguments; technical details interest some but not others, while some consider the financial side alone. But don't oversell; too much red paint may be disastrous.

The power engineer contacts many men who are neither above nor below him, such as heads of production, packaging, shipping, purchasing, accounting, legal-department heads and representatives of civic authorities and underwriter boards. Facing divergent interests that tend to develop acrimonious debates whose endings may be unfortunate, he needs wide experience with human nature. He must know when to barter, when to withdraw graciously, when to force the issue.

Yet I agree that the men under the engineer are his greatest field for constructive work. Too little attention is paid to learning the aptitudes and educating latent mental capacities of employees. If an engineer expects brain work from his crew he must give them an opportunity to use their brains and not stultify them with too many detailed orders.

And the Man Below

The best approach to a man is an occasional chat on the job, not in the office. It is an easy informal way of getting free expression and giving information. The man should be encouraged to visit other plants, read, attend night courses and join technical societies.

Having placed the men according to their aptitudes and having started their education, the next step is to make their jobs desirable. Instill the confidence of fair treatment. Work to eliminate any unfair rulings. Reward merit and encourage hope of advancement.

For every key man there should be an understudy ready to advance when opportunity arises. The understudy's aptitudes, and natural abilities should be understood before you select him. Encourage an honest pride in good work. If the pay is the average of that paid in the neighborhood for the same class of work and the job is made desirable, there will be an efficient and satisfied crew.

Opinions differ as to the most desirable type of employee. My personal preference is typified by the professional hockey player. When not directly in the play he relaxes, with his mind alertly diagnosing his opponent's play, watching the progress of the puck and looking for an opportunity. When it occurs, even though it is a long chance, he goes into action with the utmost speed and skill and stays in until there is a score or the play is taken away from him.

THE POWER EXECUTIVE

MANAGE MAINTENANCE

By **ALFRED VAKSDAL**
Plant Engineer
and **FREDERICK S. KRIGER**
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Hit-and-run maintenance is on the way out—too costly—too unfair to men and machines. A clean-cut plan in writing saves money, cuts breakdowns, builds men

AUTOMATIC operation in manufacturing requires continuous power service. Breakdown of any plant machinery will curtail production, but a failure in the power house may stop all production. Modern power-plant equipment has simplified operation but greatly complicated the function of maintenance.

Old trades are being eliminated; new ones are being created. This is the natural course of progress and will so continue as long as man is able to reason. Some time in the future we may carry on production without human labor to operate the machines, but men will always be needed for experiment and repairs. It is only through planned maintenance that machines may furnish uninterrupted power service.

The same careful attention given to organization of men and machines, the same skill and judgment applied for maximum production, must now be devoted to maintenance.

The time is gone when "Handy Jack" operated the power house. He was blacksmith and pipefitter. He dressed slipping belts, cobbled broken machinery, calked leaks, packed glands. He oiled hot bearings and greased the squeaking wheels. When steam pressure dropped he fed the brute; when the safety valve blew he opened the fire doors. When the factory was too cold he used high-pressure steam, and if pressure developed in the vacuum system, he injected cold water into the return line. He used compressed air to cool switches and fuses—necessity was the mother of his inventions. When motors mysteriously burned out he never suspected that power lines were overloaded.

If Handy Jack ran a week without a shutdown he set a record. Some one knew how much coal was burned, but no one knew how much water was evaporated. The cost of power plant maintenance was always mixed up with power power operation or general factory maintenance.

But as mechanical operation expanded with the growth of the plant, maintenance necessarily drew away from operation. In many plants the first division of labor appeared with the segregation of the pipefitters, electricians and other groups of mechanics. Yet the chaotic environment of Handy Jack is still to be found in many shops where any one man may be called to work on a great variety of dissimilar jobs.

Just as the operator has definite duties, so also must maintenance be a specific responsibility, planned and organized. The individual must be made responsible for the successful operation of the particular function of maintenance assigned to him.

Don't mother men to death; give them responsibilities. A gang of laborers were working on a job at a considerable distance from the home office. Suddenly the foreman became ill and died, leaving the men without supervision. Not knowing what to do, they wired the office: "Boss died what to do." The answer read: "If you are sure he is dead, bury him."

It is a common fault to be satisfied with one's own ability, but it is block-headed stupidity to put a man to work without definite instructions. Yet, it is still being done. A man may work all his life on breakdowns and never know that it is his duty to prevent them. Men accomplish more with less effort, greater certainty and greater safety when they have a clean-cut picture of their responsibilities.

Put a man in charge of the steam generating system; do the same with the electrical generation and distribution and with everything else. Write down his duties and relationships; tell him it is his job and explain what you expect. Make responsibilities so clear that inability to handle the job will be the only possible explanation of poor performance.

To work up such a program of maintenance in a large power house is an exacting job. Power management must study each individual piece of equipment. It must discover which parts may fail in use and how such failures may be nipped in the bud.

Write down detailed specifications of the entire power plant, including age, initial cost and replacement value. Estimate the present value of buildings, machinery and equipment. With such basic data assembled, inventory physical conditions and capacities. Then work out what must be done to meet anticipated demands for power service without interrupting production.

Set down the maintenance duties for each piece of equipment and then tie each single function of maintenance to that man in the maintenance or-

ganization who is best fitted for that particular task. Finally, install an accounting system to record expenditure—to measure effort, as well as accomplishment, of each individual.

This done, you will not only know more about your own job but will soon have an organization of skilled men who will do the right thing at the right time without being told. *Prepare* is more important than *repair;* this is the A.B.C. of any sound maintenance program.

A SAMPLE OF MAINTENANCE PLANNING

Maintenance Divisions

I. Boiler-Room Maintenance

a. Water softener
b. Feed-water heater
c. Feed-water pumps
d. Coal handling
e. Stokers
f. Ash handling
g. Furnace
h. Boilers
i. Superheaters.

II. Engine-Room Maintenance

A. A.C. generating equipment
a. Switchboard bus structure
b. Generators
c. Turbines
d. Condensers
e. Auxiliaries

B. D.C. generating equipment
a. Switchboard bus structure
b. Motor-generator sets
c. "X" engine and generator

C. Compressor, motor, engine
a. Steam-driven units
b. Electric-driven units
c. Auxiliaries

D. Water system
a. Pump, motor, controls, meters, valves
b. Fire pumps

E. Exhaust steam
a. Vacuum pump, traps, meters

F. Gas engines
a. Generator
b. Compressor

G. Service lines
a. Electric
b. Air
c. Water
d. Etc.

Maintenance Responsibilities and Instructions

I. Boiler Maintenance—(Boiler repairman responsible)

1. Feed-water regulator—Repairs as needed.
2. Drums—Inspect and replace manhole gaskets each time boiler is off line. Inspect feed-water connections. Inside and outside.
3. Tubes—Inspect and blow off each time boiler is down. Renew and re-roll as required. Turbine tubes yearly.
4. Steam Header—Inspect and clean non-return valve each time boiler is off line.
5. Blow-off valves and lines—Inspect and make needed repairs each time boiler is down.
6. Safety valves—Test yearly.
7. General—Each boiler is inspected yearly by Insurance Company for State Department. Carry out all recommendations promptly.

(etc. for other divisions)

The sample sections on this page show one way to start. While the items will differ in every plant, all good maintenance plans break down the various activities and responsibilities in detail. The functions for which each shop must be held responsible can then be accurately determined so that each foreman can distribute the different duties among his men.

A standing accounting number should be issued for each equipment unit or each group of units, so that all charges for labor and material can be segregated and analyzed. With given quantities, you can obtain standard costs on everything your men are doing. There is no reason why you can't establish unit costs for maintaining every item in the power plant.

When a condition threatening production appears, or a breakdown actually happens, it must be the constant duty of the power engineer to submit a complete report showing *why it happened* and *how it could have been prevented.* Such reports must be made available to all concerned with the making of power and be filed for easy future reference.

The plan outlined must not relieve the operating personnel of continuous inspections, the results of which must be daily recorded on the log sheet for the maintenance man's benefit.

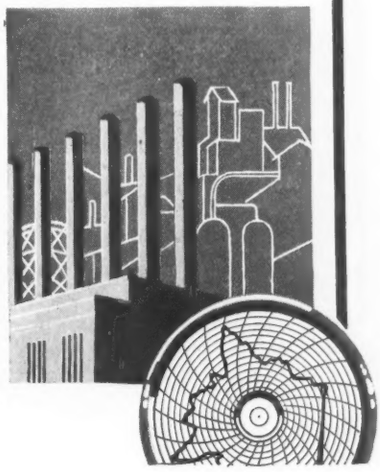
A continuous account of this work will soon prove that break-down repairs are generally proof of neglect.

With such an arrangement the men have more opportunity to prove their abilities and the foreman will be better able to award just compensation. Without such records the foreman will have no effective control of his department and company executives will still view maintenance merely as a necessary nuisance.

Proper coordination of duties, and just compensation based on performance, promotes cooperation. Individual responsibility fosters initiative and loyalty. To have a job that is your own, with freedom to plan your work, furnishes a much greater incentive than to ring hours on your time card and to depend on others to tell you what to do.

Some still fail to see this. A while ago a foreman sent through a discharge notice for one of his men. Asked why, the foreman said, "He was crazy." "How did you find out?" "My God," he replied, "he worked after the whistle blew."

When everybody is planning for better service, and effort is wisely directed with justice and kindness, men will be happy and will give you their best.



THE POWER EXECUTIVE

PLAN OPERATION

By E. H. BARRY
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Know the designer's intent. Plan maintenance for high-quality service. Measure efficiency and work with the power user. Write instructions.

IT IS HARD to picture operation without plan, because the very essence of the function of a power plant is the uniformity and dependability of its services. In a large plant these may include electric power, process steam, heating and ventilation, hot and cold water, refrigeration, compressed air. There may, of course, be other services, depending on the nature of the industry. Planning is a prerequisite to their successful generation and distribution.

Planning enters plant operation by many avenues, and with respect (among others) to the following considerations:

1. Operation of the plant in conformity with the designer's intent.
2. Continuity of services.
3. Economy of operation.
4. Quality of service (maintenance of steam and air pressures and temperature, constant frequency, etc.)
5. Plant maintenance.
6. Operating labor.

The relative importance of these factors is not necessarily in the order named. *Continuity* undoubtedly is most important.

Let us assume that a new plant is about to be placed in operation. The operating engineer must first thoroughly understand the function of each component part of that plant and its limitations. He must be familiar with the designer's intent and plan operation accordingly. This calls for cooperation between the operator and designer of the plant, both before and after starting operation.

An example will make this clearer. It was not many years ago that bleeder turbines were first introduced into industrial power plants. Before that, live steam was passed through a reducing valve to process. Operators of the older school were often not alive to the economies to be obtained by thus using bled steam; they failed to take advantage of the means provided for bleeding the turbines.

After the plant has been started, the operator must keep it in continuous operation and maintain uniform quality of service. To this end he must definitely know the condition of every part of his equipment. This necessitates a comprehensive program of periodic inspection and the stocking of repair parts. He must also be prepared to cope with emergency shutdowns. Too many costly interruptions result from the engineer's failure to uncover the seeds of trouble by a program of systematic inspection. Careful planning would provide for such inspections during intervals of light load.

This applies especially to electrical equipment. Steam equipment usually gets the most attention, since warnings of trouble are more apparent, showing up in steam leaks, loss of capacity, and falling efficiency.

Maintenance of plant efficiency is of major importance. An ample assortment of measuring instruments, preferably recording as well as integrating, is required for measuring quantity flow, in addition to instruments for indicating and recording state or condition, such as temperatures, pressures, CO_2. It is axiomatic that all instruments should be kept in first-class condition and checked periodically for accuracy, yet this phase of planned operation is often neglected.

The Customer

Cooperation of consumers will greatly help the operator to maintain plant efficiency. He can often effect remarkable savings by scheduling demands to avoid costly load peaks. This cooperation is sometimes carried to the point at which a steam and power dispatcher serves as a clearing house for supply and demand for power services.

The relations between the plant engineer and his operating personnel are a fertile field for intelligent planning. The complexity of modern power plants requires that the operators thoroughly understand their individual functions and their relation to the functions of other elements of the plant. Some plants run night schools to educate operators who have not had the advantage of technical school training.

It is an excellent plan to place in the hands of the operating personnel written descriptions of new apparatus and instructions for its operation. Preferably this should be done before the equipment is installed.

The rules of the N.R.A., and of employees' labor organizations, add to the difficulties of planned operation, but these are by no means insurmountable. They do, however, make necessary an even closer cooperation between the engineer and his operating personnel.

LOOK AHEAD

By PHILIP W. SWAIN
Editor of POWER

Planning for growth and change is a fine art. No man can be always right in his estimates of the future but experience raises the batting average and teaches how flexibility may absorb the shock of unexpected trends.

CONSCIOUSLY or unconsciously, the good executive must work with the laws of probability. Based on his own experience and that of others, he arrives at a handful of good guesses: This seems sure; that is probable; another thing is quite possible and still another barely so. No one—not even the man himself—can know just how he arrives at such conclusions; the human brain is still an unfathomed mystery. But we do know that some men consistently hit much better than others in future estimates.

Asked the secret of his success, Andrew Carnegie once said "I always make it a point to associate myself with lucky men". You can get the point without any superstitious belief in the "lady luck" of the horse fans. Carnegie merely found a smart way to say that some men are so constituted that they consistently do the right thing more often than other men, and that he made it a point to hire them.

The power executive can apply this principle in selecting the men who are to work for him and the chief executive for whom he, in turn, is to work. Hitch your wagon to half a dozen stars. Pick assistants who have always been "lucky" in such matters as accidents, family relations, plant breakdowns. Pick for your boss the man who has been consistently "lucky" as a manufacturer and business man—above all one who has been lucky in his power engineers.

We all know that the chances of correct prediction are less and less as we look further into the future. Quite aside from the matter of interest on investment, a sure benefit now is always worth more than a probable equal benefit in the future. And the more distant that future the less the present value, because time lapse increases the possibility that the "probable" may never happen.

All good executives use this principle whether they realize it or not. Here's proof. Present the average power executive with the following problem:

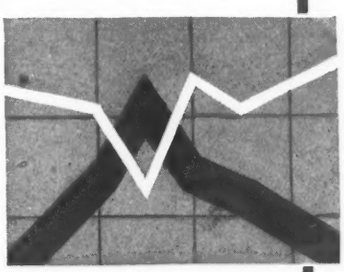
Assume that you can borrow at six per cent, with no limits on amount or term of the loan. You are offered two plant investments, one of $100,000 and one of $50,000. The former will yield a clear yearly saving (*after interest, depreciation and other fixed charges*) of $8,000—the latter a return of $7,000. Note that you don't have to put up a penny of your own money, except interest, sinking fund deposits and other fixed charges, all of which have been accounted for. Thus it is clear that you are ahead $1,000 every year (actual money in pocket) if you pick the $100,000 investment. Now choose!

In the majority of cases the executive will pick the $50,000 investment, and probably do so wisely. When analyzed, his motives for throwing away $1,000 yearly are fear of future change in general business conditions, or in his own business, or the sudden appearance of unexpected obsolescence. He fears that the present savings may not continue indefinitely, so that his additional $50,000 investment may be wasted. He is willing to pay $1,000 yearly insurance to avoid the possibility. But if he is a good executive he will not go around always choosing the present crackers and milk in preference to the future cake. The insurance may come too high.

Another form of insurance consists in spending slightly more, when modernization is under way, for the sake of future flexibility—ability to meet the unknown. It's done every day in sport—in football, tennis, boxing, baseball. The player expects one thing to happen, but he rarely stands in the position that would be best if that did happen. He thinks it wiser to shift just a little from that spot in order to be prepared to get somewhere else in a hurry if the unexpected happens. This sacrifice of a slight advantage in the normal play is his insurance premium. Likewise, the skill of the power executive is measured very largely by his ability to delay obsolescence by putting flexibility into his layouts.

There is space to make just one application. Let us say that you are modernizing at considerable expense, by raising steam pressures to eliminate exhaust-steam waste. A pressure of 400 lb. will do the trick now, but it may be smarter to jump to 500 lb., or even more, because you can't go wrong in heat economy with too high a pressure and might with one too low. Heat and power loads may change, probably will with improved processes. Only don't go too far, for then your insurance will cost more than the risk is worth.

It's a great game, this planning for growth and change, this attempt to outwit the future. Its challenge to keen minds is one of the things that attract first-rate men to the strenuous tasks of power engineering—and holds them there.



THE POWER EXECUTIVE

KEEP COST RECORDS

Through the maze of power cost-keeping details runs a thread of simple logic. There's the framework on which to hang any cost system

By

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BEHIND every intelligent move to improve plant operation lie power records—the automatic records of instrument charts, operating logs, cost records. Fairly kept, these records are facts, and facts are the first step in every program of engineering progress.

Many engineers have written much about the selection and use of recording instruments, the filing of instrument charts, suitable forms for operationg logs, and their proper use. No attempt will be made to discuss all these types of records. Space is limited, and the treatment would be too general to be of great practical value. Let us concentrate, therefore, on costs, which are, after all, the ultimate reason for instruments and logs.

The basic principles here outlined were first presented in the Power Cost Number of *Power* (Nov. 21, 1931) but have since been simplified and checked against the actual practices of many industrial plants. The authors feel that their general adoption by power engineers will reduce power dollar waste everywhere in American industry and improve services. It should be made clear that this is not an attempt to impose some exact "system" in detail. All must recognize that a system suited to the needs of a large plant will be top-heavy, too complex, for a small plant.

Let us start with the power services. They are primarily steam, electricity, water, refrigeration, compressed air. Heating, ventilation and air conditioning, while generally listed as power services, are not often measured directly as such, but are "assembled" by consuming departments from electricity, steam, etc.

These aside, each power service is a simple fluid commodity, made up of units all alike, which may be measured by flow-meters or otherwise.

Their measures are:

1. Steam—M pounds at a given pressure and condition.
2. Electricity—kilowatt-hours.
3. Water—M pounds at a given pressure and temperature.
4. Refrigeration—"Tons" or B.t.u. at a given temperature.
5. Compressed air—M cubic feet at a given pressure.

There may, of course, be two or more kinds of each of these services. A.C. and D.C. electricity, for example, will have separate costs, and may be looked upon as two separate services.

Steam is generally of two kinds: High-pressure (boiler pressure), low-pressure (process and heating pressure). Certain large plants with complex hook-ups may break steam services down, according to pressure and condition, into three or four important classifications. Many plants, however, find it best to express all lower pressure steam in terms of the equivalent heat value of high-pressure steam.

Refrigeration can hardly be simplified in this way, because one unit of refrigeration (either ton basis or B.t.u. basis) will obviously be worth much more and cost much more at a lower temperature. Thus, if refrigeration is supplied at two markedly different temperatures, they should be figured as separate power services.

Using these slight complications where necessary, we get the picture of the over-all power-service plant delivering a group of perfectly defined fluid services, each of which can be "measured by the quart," as it were. This is an ideal condition for a clean-cut accounting system, because it permits finding the unit cost of each fluid service and distributing that cost (with the aid of meters) to using departments.

The power-service plant, as a whole, is producing these services, and nothing else. Its grand total operating cost must be exactly equal to the combined cost of the power services produced. To get anywhere, however, we cannot stop with the "sewer" system of accounting, in which all power service costs are dumped down a single manhole. With this system, still widely used, it is impossible to know or control the unit cost of individual services.

So let's get back on the highway of sound power service accounting. We want to know the cost of each service and its quantity and unit cost. To do this we must track down the plant that produced it. Right here we need a new definition of a "plant."

For our accounting purposes we shall define a "plant" as a group of machines that produces one or more power services. Thus, the boiler "plant," generally the most important, produces high-pressure

steam only. The steam-electric plant produces only electricity plus bled and/or exhaust steam.

The pumping plant produces pumped water, and may also produce low-pressure exhaust steam. The diesel-electric plant and hydro-electric plant produce electricity, and the diesel-electric may also produce hot water or steam or both.

All this may sound a bit complex, but in practice it need never be more so than the necessities of the case warrant. Just pick the equipment groups ("plants") that are important in the given factory, and then soak up the odds and ends of equipment and services in some convenient catch-all. This can be done, as will be shown later, without undermining the system.

In practice, then, we look at our particular power services and spot those that are produced in worthwhile quantities. We spot also those plants whose dollar output is large enough to worry about.

From what has already been presented, it will be a simple matter to list the major services (each clean cut) for which cost records are to be kept. It will be just as easy to pick out the unit plants if you forget building walls and other structural boundaries, and consider which equipment does what. Walk through the aggregate plant with an imaginary piece of chalk in hand. With it draw an imaginary "circle." (It may actually be any shape up to a figure eight) around all the equipment that generates a given service in a given way.

Thus, you will draw one circle about the steam generating plant, another about the steam-electric (engine and turbine) plant. You can, of course, split this latter into a turbine plant and engine plant, if you wish. Do the same for the diesel-electric plant, the compressed-air plant, refrigerating plant, water-pumping plant.

Finally, you will find certain odds and ends that are hard to classify in any of the above accounts. These may include maintenance of steam return pumps, traps, reducing valves, electric motors in manufacturing departments, etc. Draw one circle around all of these odds and ends, and call them the "miscellaneous" or "unclassified" plant.

Some people object to a miscellaneous account of this sort. The fact remains that there are always cost items that don't conveniently fit anywhere, but must somehow get into the total power service cost of the factory. They must be pigeonholed somewhere, either in a miscellaneous account or by arbitrary division among the recognized plants and services. It makes little difference which you do, as long as the amounts concerned are small. The "miscellaneous" habit is dangerous only where it is used to bury large hunks of ignorance; then look out for trouble!

Common-sense accounting never carries the system so far that the last penny saved in plant operation is wasted in extra clerical payroll. This is basic; nothing in this article should be interpreted to the contrary.

One very important check on this "chalk circling" procedure is this: when you get through, every piece of power equipment must be included in one circle

Fig. 1—Services produced carry all costs of operating the subplant

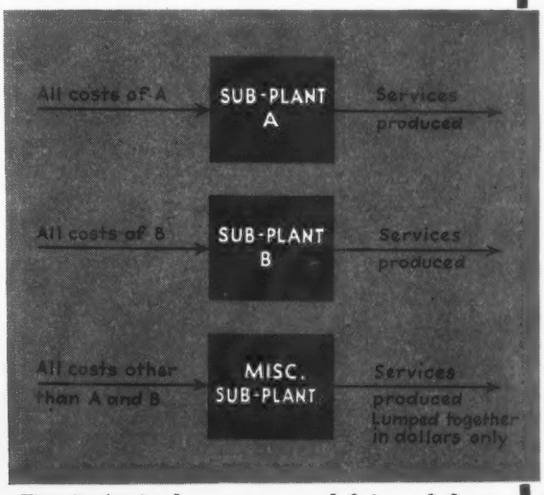


Fig. 2—A simple set-up—two definite subplants and one "miscellaneous" subplant to cover minor odds and ends of equipment and services

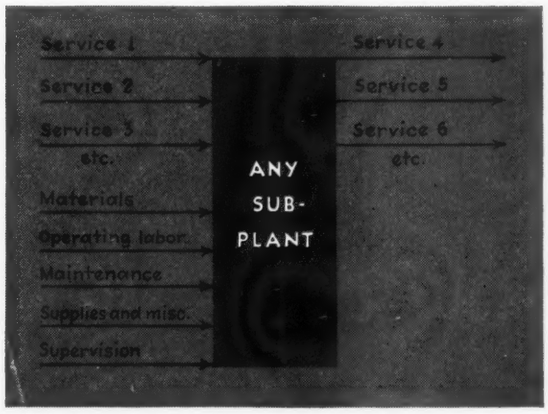
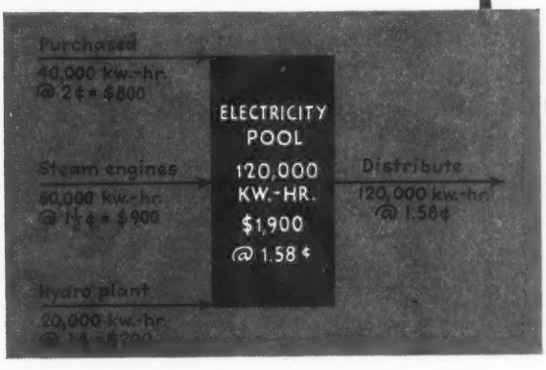


Fig. 3 (Above)—Simple breakdown of cost entering a subplant. Fig. 4 (Right)—When a single service comes from several plants, pool quantities and dollars to get correct unit cost for distribution



THE POWER EXECUTIVE

or another. Don't leave anything out, even if it be a bunch of air compressors or pumps out in the factory far away from the power-house.

Now let's see what we have. Fig. 1 stands for any one plant (here labelled a "sub-plant"). The "circle" is represented by a rectangle. Pay no attention to what happens *inside* the "circle." Just note that money goes in and services come out. It's A-B C that the money comes out buried in these services; the salable output must naturally carry the entire cost.

Fig. 2 extends the same idea to a small industrial with two worthwhile plants (which might be steam generating plant and steam-electric plant) plus a "miscellaneous" plant to soak up all items not covered by A and B.

Here, again, we get the cost of each service. An apparent complication comes in when one plant produces two or more services. Plant B, for example, may produce both electricity and exhaust steam. You know the combined cost of the two, but how shall they be split? This is a favorite theme of plant debate; more about it later.

Now return to one of these plants. You may wish to know not only what the service produced (say, steam) costs, but also how this cost is broken down. Fig. 3 shows one simple way to do it. Fixed charges are not shown. For lack of space, this article will not discuss how and when they should be included.

A single service may be produced by several plants, with a different unit cost for each. At what cost shall this service be distributed to the factory? Fig. 4 shows the answer for a case where electricity comes from three sources: purchase, engine plant and hydro plant. Pool all the kilowatts and all the electricity dollars delivered by each. Divide total dollars by total kilowatts to get a single unit cost for distribution.

To make practical application clearer, Fig. 6 charts a complete power-service cost set-up for a small factory with only three plants: steam generating, engine and miscellaneous. Note its simplicity and clearness.

Fig. 7 shows a complete steam-generating plant sheet for the same factory, covering all necessary items (indicated by check-marks). *Name* of unit is entered in second column and *number* in fourth.

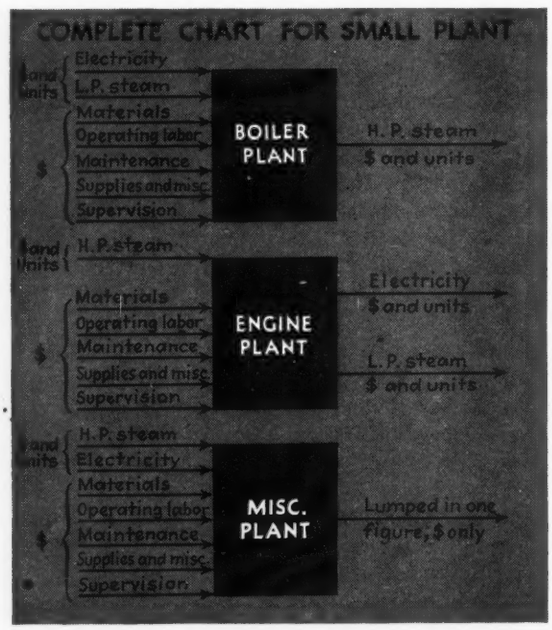
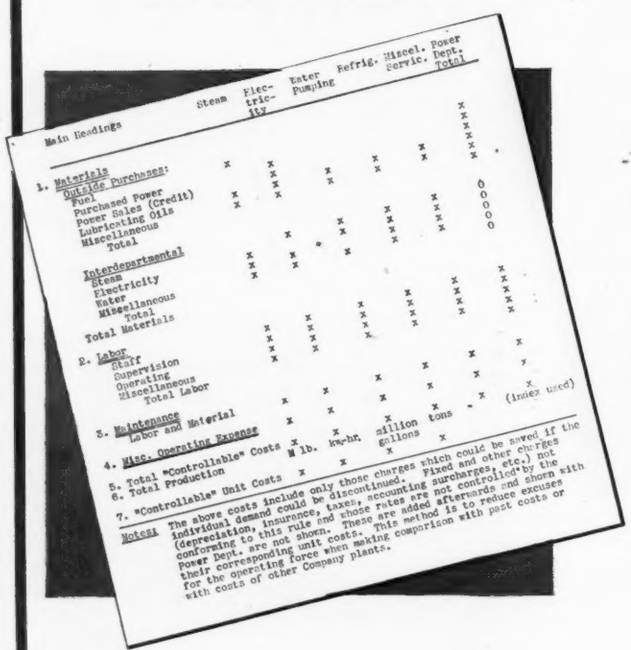


Fig. 6—Complete breakdown for a small factory steam power plant whose important services are steam and electricity

Fig. 5—Power cost sheet (outline only) used at Kodak Park Plant, Eastman Kodak Co.


Main Headings | Steam | Electric-ity | Water Pumping | Refrig. | Miscel. Service. | Power Dept. | Total

1. Materials
Outside Purchases:
Fuel
Purchased Power
Power Sales (Credit)
Lubricating Oils
Miscellaneous
Total
Interdepartmental
Steam
Electricity
Water
Miscellaneous
Total
Total Materials

2. Labor
Staff
Supervision
Operating
Miscellaneous
Total Labor

3. Maintenance
Labor and Material

4. Misc. Operating Expense

5. Total "Controllable" Costs
6. Total Production
7. "Controllable" Unit Costs — M lb. | kw-hr. | million gallons | tons

(index used)

Notes: The above costs include only those charges which could be saved if the individual demand could be discontinued. Fixed and other charges (depreciation, insurance, taxes, accounting surcharges, etc.) not conforming to this rule are not shown. These rates are not controlled by the Power Dept., are not unit costs. These are added afterwards and shown for the corresponding force when making comparison with past costs or with costs of other Company plants.

Fig. 8 is the master power cost sheet covering all the power services and designed to fit practically any kind of power plant anywhere. To apply this form to a given plant, first cross out all columns and lines that do not apply locally. Then redraw the chart in condensed form with these eliminated. For example, the check marks indicate all entries that would be required in a certain industrial. The engineer of that factory can then prepare his own master power cost sheet by redrawing this one, eliminating all columns and lines that contain no check-marks. This gives him a simple, but complete, summary form.

Note that the bottom half of the chart merely pools the services as indicated in Fig. 4. Note also that the figures in the line marked "Total Value Plant Output" must be the same as those vertically above in the line, "Total Cost of Plant Operation."

The "Unclassified" column is that previously re-

ferred to as "Miscellaneous" plant. Its recorded output is in *dollars only.* Ration this total dollar cost of miscellaneous services to factory departments on any simple basis, such as floor area or payroll.

A plant has been set up in the next to the last column for purchased electricity. Its "fuel" is the raw

STEAM COST

ITEM		UNIT	UNIT COST	UNITS	TOTAL COST
Outside Services	Electricity	✓	✓	✓	✓
	L.P. Steam	✓	✓	✓	✓
Fuel		✓	✓	✓	✓
Water		✓	✓	✓	✓
Other materials					✓
Operating labor					✓
Maintenance					✓
Supplies and misc.					✓
Supervision					✓
		Total operating cost steam			✓
		M. Lb. produced			✓
		Unit cost, ¢ per M.			✓

Fig. 7—Steam cost sheet for factory of Fig. 6

Fig. 8—Master power-cost sheet to fit any type of establishment

electricity, where it first touches plant property. Its "plant" is all equipment used to transform and convert this to electricity at the factory switchboard. Its output, of course, is electricity, but slightly less than the amount purchased by the loss through transformers and complete conversion (which may include M.G. sets).

One thing more before we stop, for lack of space. Turn to the engine plant (Fig. 6). It cannot be disputed that electricity and low-pressure steam together must carry the entire cost of operating this plant, but how much each?

Where part of the exhaust goes to heating or process, the authors recommend entering in the output of the engine plant only the low-pressure steam usefully employed, and expressing it in terms of the equivalent quantity of high-pressure steam (based on heat value measured above the temperature of the returns, not above 32 deg. F.) Then apply the unit cost of high-pressure steam to this corrected quantity of low-pressure steam to get the dollar value of the low-pressure steam produced. Subtract this from the cost of operating the engine plant to get the cost of the electricity produced.

Except for Fig. 5, it should be noted that the forms here shown are not those actually used at Kodak Park and Corning Glass. Naturally each of the three authors has his own ideas on accounting details. Moreover the Master Power Cost Sheet was drafted by Swain long after the existing systems were established in the two plants. It is an attempt, somewhat idealized, to make a pattern that will include the requirements of almost any plant. It contains several columns which most industrials can cross out.

The generalized system here outlined gives a quantity, a total cost, and a unit cost for each power service. It points the way to reduced unit costs and total costs. *Another big problem is that of reducing the quantity consumed.* The major step here is to insure the co-operation of consumers in the factory by metering their service consumption by departments.

MASTER POWER-COST SHEET

		Item	Unit	Unit Cost, $	PLANTS: Boiler	Engine	Diesel	Hydro	Pumping	Hot Water	Compressor	Refrigeration	Unclassified	Purchased	Total
PLANT OPERATING COST IN DOLLARS		Coal	Tons		✓										✓
		Fuel oil	M. Lb.				✓								✓
		Other fuel											✓	Water	✓
		Water	M. Lb.		✓		✓			✓			✓		✓
		Other materials			✓	✓	✓			✓			✓	✓	✓
		Operating labor			✓	✓	✓			✓			✓	✓	✓
		Maintenance			✓	✓	✓			✓			✓	✓	✓
		Supplies and misc.			✓	✓	✓			✓			✓	✓	✓
		Supervision			✓	✓	✓			✓			✓	✓	✓
		Fixed charges (*optional*)													
SERVICES USED BY PLANTS	A	Mechanical power	Hp.Hr.												
	B	Electricity	Kw.Hr.	✓	✓								✓		✓
	C	High-pressure steam	M. Lb.	✓		✓				✓			✓		✓
	D	Low-pressure steam	M. Lb.	✓	✓					✓			✓		✓
	E	Pumped water	M. Lb.												
	F	Refrigeration	Ton Day												
	G	Compressed air	M.Cu.Ft.												
	H	Hot water	M. Lb.								✓		✓		✓
	I	Unclassified	No unit												
		TOTAL COST OF PLANT OPERATION			✓	✓	✓			✓			✓	✓	✓
QUANTITIES AND COSTS OF POOLED POWER SERVICES															
TOTAL COST, $	A	Mechanical power		$											
	B	Electricity		$		✓	✓							✓	✓
	C	High-pressure steam		$	✓										✓
	D	Low-pressure steam		$		✓									✓
	E	Pumped water		$											
	F	Refrigeration		$											
	G	Compressed air		$											
	H	Hot water		$			✓			✓					✓
	I	Unclassified		$									✓		✓
		TOTAL VALUE OF PLANT OUTPUT		$	✓	✓	✓			✓			✓	✓	✓
QUANTITIES	A	Mechanical power		Hp.-Hr.											
	B	Electricity		Kw.-Hr.		✓	✓							✓	✓
	C	High-pressure steam		M. Lb.	✓										✓
	D	Low-pressure steam		M. Lb.		✓									✓
	E	Pumped water		M. Lb.											
	F	Refrigeration		Ton Day											
	G	Compressed air		M.Cu.Ft.											
	H	Hot water		M. Lb.			✓			✓					✓
UNIT COST, $	A	Mechanical power		$											
	B	Electricity		$		✓	✓							✓	✓
	C	High-pressure steam		$	✓										✓
	D	Low-pressure steam		$		✓									✓
	E	Pumped water		$											
	F	Refrigeration		$											
	G	Compressed air		$											
	H	Hot water		$			✓			✓					✓

THE POWER EXECUTIVE

EXPERIENCE SPEAKS

Here are bits of power management philosophy—straight from the field —the final conclusions of engineers who have been through the mill

IT HAS been my observation, confirmed by numerous instances, that an isolated power plant can be successfully operated only when a competent engineer has been placed in charge and given full authority to operate the plant, unhampered by any intermediate supervisory authority.

R. H. Macy & Co.
New York, N. Y.

JOHN COGAN
Engineering Councillor

IT IS the business of the Boss to get along with good men.

Pennsylvania Sugar Co.
Philadelphia, Pa.

DAN GUTLEBEN
Plant Engineer

IN POWER generation, reliability in equipment is essential, but reliability in men is paramount and more necessary than efficiency in either. Reliability is the cornerstone in the foundation of a successful operating organization.

Forstmann Woolen Co.
Passaic, N. J.

F. L. BRADLEY
Plant Engineer

A THOROUGH chief engineer trains the men under him to exercise ingenuity constantly; familiarizes them with all operations and repairs of boilers and machinery. This reduces the operating cost and his men develop the ability to overcome all obstacles.

Taylor Instrument Companies
Rochester, N. Y.

W. J. GESSNER
Chief Engineer

MY FRIENDS who are successful engineers are also executives with the happy faculty of "getting along" with the men they employ, probably realizing that the prestige they enjoy is primarily due to the "success," shall I say, of their subordinates.

Hotel New Yorker
New York, N. Y.

WARREN D. LEWIS
Chief Engineer

PROBABLY the biggest single factor in successful power management is the decision to run the system and not to let the system run you.

Champion Coated Paper Co.
Hamilton, Ohio

GUY B. RANDALL
Power Engineer

WHY waste time comparing what you did last month with what you did a year ago? Find out what your equipment is capable of doing, and compare today's performance with that.

Stone & Webster Engineering Corp.
Boston, Mass.

W. F. RYAN

ALWAYS consider, in choosing men, policies or equipment, that their efficiency when they aren't working is zero, and that it doesn't take very many idle hours a week to spoil an otherwise very excellent performance.

New Haven Pulp & Board Co.
New Haven, Conn.

H. D. FISHER
Plant Engineer

DO NOT labor under the delusion that you KNOW IT ALL. Read POWER regularly and see for yourself how much better the other fellow does things.

Scribner Realty Co., Inc.
New York, N. Y.

JOHN G. ELSMAN
Supervising Engineer

HAVE complete cost records, analyze and compare them carefully, making due allowance for production changes and other variable factors, and the efficient operation of the power plant will follow in natural course.

American Chicle Co.
Long Island City, N. Y.

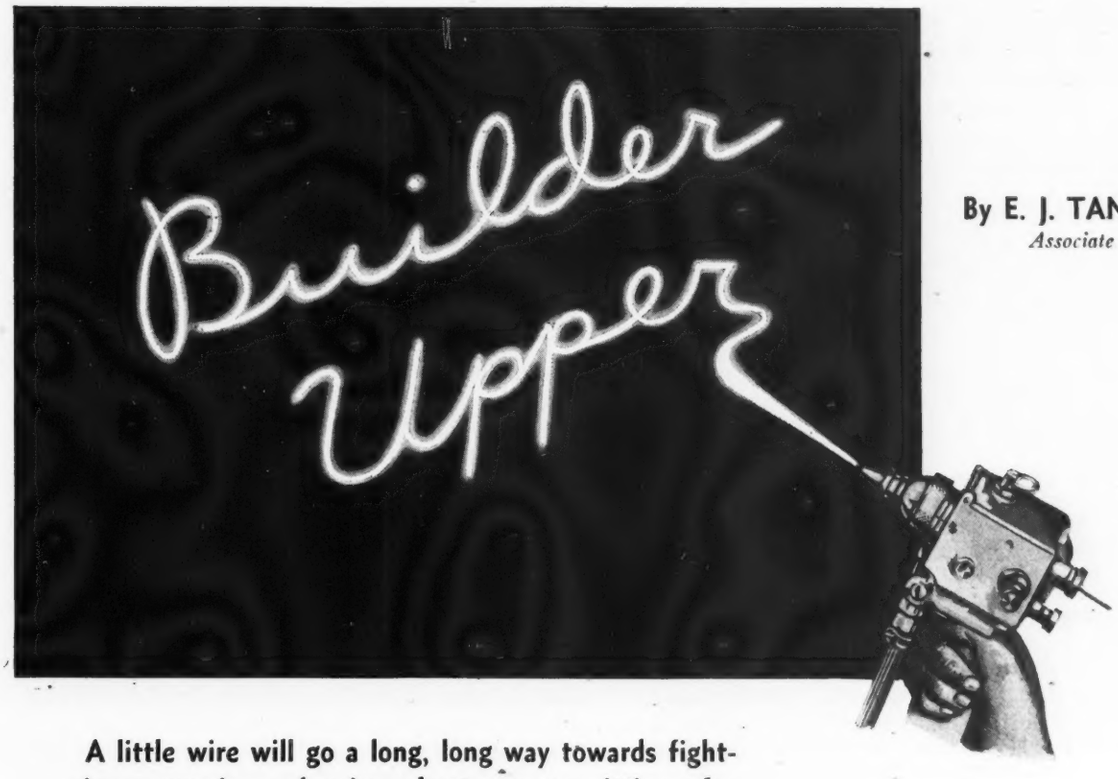
C. E. DEVIVO
Plant Engineer

IN THE power plant, performance tests show what may be expected under given conditions, but it is the daily operating log that tells whether the apparatus justifies its cost under regular operation.

Nat'l Sugar Ref. Co. of N. J.
N. Y. Refinery, L. I. City

B. A. MAYHEW
M. E. in Charge of Steam Plant

Builder Upper



By E. J. TANGERMAN
Associate Editor

A little wire will go a long, long way towards fight--ing corrosion, abrasion, heat, wear, pitting—for now any of a dozen metals can be melted and sprayed like paint to stick like anything to anything

FORTY years ago a metallurgist's dream, twenty years ago a field for experiment, five years ago a process, during the last year or two an increasingly useful power plant tool—that is the history of sprayed molten metal coatings. At first for corrosion resistance, now for heat and fire resistance, electrical conduction, building up worn or undersize or underweight parts and for decorative effects—that is the trend of application.

A gun melts, atomizes and sprays coating of any commercial metal on surfaces regardless of size, shape or material. "Gun" is the proper name too, for the molten particles strike at 5 to 10 miles a minute, only slightly slower than shotgun pellets. Be the surface fine lace or rough casting, so long as its surface is clean and rough enough for the flying droplets to make a bond, they'll stick, and they'll keep on sticking until a coating of the desired thickness is built up. The metal, whether lead, tin, zinc, aluminum, copper, brass, bronze, phosphor bronze, nickel silver, Monel, stainless steel, high- or low-carbon steel, is introduced as wire from 20 B & S gage (0.032 in.) to $\frac{3}{16}$ in. in diameter.

Composition or inflammability of the surface causes no trouble, for the molten pellets cool in less than a hundredth of a second, thus set up no heat stresses and spoil no heat-treating. In this respect the process beats welding or brazing, for the base material never reaches high temperatures. The coating is simply a deposit of droplets held interlocked by interlacing of their spattered edges as they strike. By the same token, the process is no good for joining structural members and of doubtful value when a small area is to be covered with a heavy deposit. Its prinicipal job is as the mythical "putting-on" tool that every maintenance man has prayed for—a reliable method of covering large areas with a thin coating.

One bugaboo of sprayed metal coatings has been electrolysis, caused by battery action between the base metal and a dissimilar coating. The need is to get metals "anodic" or protective to the base metal. Zinc, aluminum and cadmium are anodic to iron, thus protect it best. Tin or copper coats accelerate corrosion if moisture can get through to the base. Lead and tin, extremely valuable in resisting corrosion from most commercial acids, must thus be applied heavily or they will make matters worse. Copper is likewise good, but beware of moisture penetration. Brass, bronze, Monel, nickel and nickel silver all accelerate corrosion of iron, but sometimes are the best materials to fight a specific set of conditions. The answer is thick coatings, proper bonding and proper combination of coatings. Aside from this, zinc, aluminum and lead have the very desirable characteristic of corroding only until a protective coating of salts is formed on the surface, then preventing further corrosion of themselves or the base metal.

Another bugaboo has been unequal rates of expansion of base and coating where temperature variations are great. This has been whipped by changing coating composition slightly, except in a very few cases of unusually great expansion.

Metal spraying requires two distinct pieces of equipment, sand or grit-blaster and spraying gun. Any good blaster will handle the job. Three American companies build spray guns in sizes to give a variety of coating speeds and convenience in getting into tight places. Their

basic principles are the same. The gun, weighing 2½ to 5 lb., is essentially an aluminum box containing a 15,000-55,000-r.p.m. compressed air turbine driving knurled wire-feeding wheels through a gear train. Incoming wire moves into a cone of oxy-acetylene or oxy-hydrogen flame, where it is melted. Just as it reaches the melting point, it is caught by an outer cone of compressed air, atomized and driven through the nozzle. The compressed air also keeps the gun cool. Either a 3-way valve controls air, oxygen and acetylene supplies (in which case adjustment must be made at the air control valve and gas cylinder regulators) or individual control valves are provided on the gun.

Standard guns spray a circle about 2 in. in diameter when held 5 in. from the surface, the coating per pass being 0.001 to 0.006 in. thick, depending upon the metal. Any metal that melts below tantalum's melting point (5250 deg. F.) can be sprayed, the rate running from 6-12 sq.ft. per hr. for iron to 60-120 sq.ft. per hr. for lead, the coating in each case being 0.006 in. thick. Wire feeds run 10 to 35 ft. per min., depending upon melting point. Oxygen and acetylene pressures are 13 to 15 lb. per sq.in., air pressures 45 to 75 lb. per sq.in., varying with metal, gun, and job. Larger guns vary these rates somewhat, but of course are suitable only for coating large areas, such as gas holders and tanks. Special guns use powdered metal instead of wire, and special nozzles are also available. These include fan nozzles throwing a spray of ⅜ in. thick and 1½ in. wide and angle nozzles set at 45 deg. to the axis of the gun. Rotating nozzles for coating interior surfaces have extensions of 30 in. to 12 ft. to pass inside 1-to-4-in. inside diameters and extensions up to 30 ft. for coating inside diameters of 4 in. and larger.

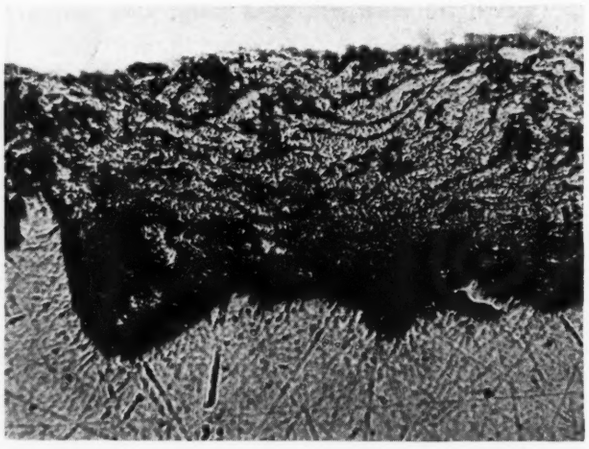
Corrosion Prevention

Zinc, aluminum, stainless steel, lead and cadmium are the principal metals sprayed on for corrosion prevention. Zinc and aluminum are usually applied at least 0.005 in. thick in air, 0.010 in. thick to combat corrosion under immersion. Lead may be anywhere from 0.015 in. to 1/16 in. thick, the thicker coatings to fight stronger corrosives and give longer service. Bronze, Monel, and the various steels, the so-called "hard" metals, are not impervious when sprayed alone, unless the coating reaches 0.020 in. or thicker. It may be cheaper to apply thin coatings of the hard metal over or under coats of the softer metals such as zinc or lead. The hard metal then gives the resistance, the soft metal fills the pinholes. Of course, if the soft metal is sprayed over the hard, it soon wears away, except in the pits and low spots, where it fills and stays.

Aluminum, of which I shall say more later, is the principal material used to combat heat corrosion on exhaust pipes, stacks, etc., being applied 0.005 to 0.010 in. thick. Zinc may also be sprayed over once-galvanized surfaces (such as those where welded joints are made on galvanized piping) to prevent corrosion at these points. Though it costs more than dip galvanizing, it is much more flexible.

Abrasion resistance, or abrasion combined with corrosion resistance, requires final coats of the harder metals, such as steel. Worn shafts, sleeves, bearings, cylinders, and pump linings can be reclaimed, often with the same metal as the base. Cost runs 5 to 50 per cent of replacement; wear is as good, sometimes better. In shafts particularly the porous structure of the sprayed-on coating seems to hold the oil, thus giving better lubrication and longer service. Coatings may be put on slightly oversize, then machined to fit. Bond is usually so good that keyways or grooves may be cut the full length of the coated section without danger of "lifting" the coating. A case in point is that of a 7-in. flywheel bearing on a 3-in. shaft. When the flywheel became loose, the shaft was machined 1/16 in. undersize, threaded and sandblasted, then built up with 1¼ lb. of ⅛-in. carbon steel (plus 15 cu.ft. each of oxygen and acetylene) in 15 min. The keyway was recut for the full length of the bearing and the surface machined down (1 hr. lathe time). The job has been in service for several years.

Shafts are usually built up in a lathe, machining ⅛ in. undersize, cutting a 32 thread 1/32 in. deep (wherever deposit is to be over 0.020 in. thick), sandblasting, then coating with the gun held in the toolpost of the lathe and fed forward 1/16 to ⅛ in. per revolution, with the surface revolved at 25 to 50 ft. per min. Thickness of coating may run 1/32 in. to ¼ in. Sprayed metal reacts somewhat as does cast metal to machining. A round-nose tool taking fine cuts is used for softer deposits, a pointed tool for harder ones. In either case if a smooth surface is required it is best to finish by grinding—in fact the whole cleaning up operation can be done that way, with less wastage of metal. This also avoids the danger of "lifting"



Steel with 0.003-in. zinc coating, etched and enlarged 300 times. Notice the keyfasts created by sandblasting

the coating when it has been applied over large areas. Allowances are usually 0.020 in. oversize if finish is to be by grinding, 0.040 if by machining.

If the surface is very small and the coating thick, take time out between passes to avoid overheating, but this isn't necessary even on a 2-in. shaft 12 in. long built up 1.16 in. thick.

It is also possible to build up inside surfaces subject to abrasion, such as pump and cylinder walls. An 11x16-in. gas-compressor cylinder, badly pitted, was bored out 1/16-in., then sprayed with cold-rolled steel and remachined. The result was a wall varying between 1/16 and ⅛ in. thick, filling the pitted areas and giving two years of service so far without appreciable wear. Materials were 21 lb. ⅛-in. cold-rolled wire, 252 cu.ft. oxygen, 226 cu.ft. acetylene. Spraying time was 6 hr. 10 min., machining time 5½ hr. Total cost was under $30.

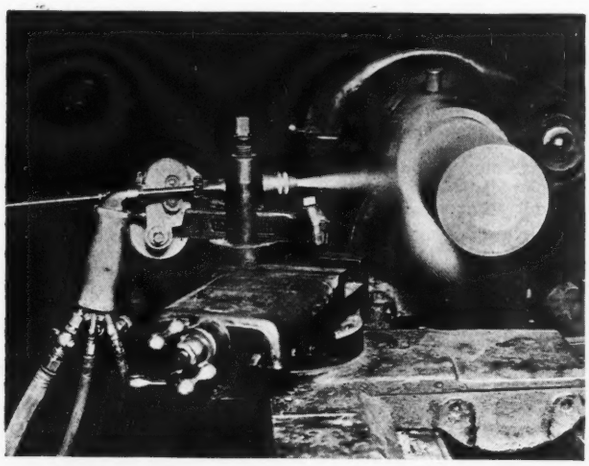
An Eastern ice company has also been building up inside diesel cylinder walls. These cast-iron liners are

rebuilt with high-carbon steel, and give life three times longer than the original liner. If low-carbon steel is used, the liner wears out almost immediately.

Perhaps a few tips to the metal sprayer will not come amiss. Gun operation is simple and can be learned in a few hours. (It's about as difficult as operating a cutting torch.) Any intelligent mechanic can handle the usual run of work. The exceptional job still, of course, requires the skilled operator.

First and most important is the matter of preparing the surface. It is essential to clean and roughen it to insure proper bonding, for the only way the flying particles can anchor is by interlocking with the tiny pits which form keyfasts in the surface. Almost all metal surfaces are covered with oxides, oil, water or scale, which must be removed by sand- or grit-blasting or both. Sandblast with a good grade of silica sand or steel grit—16-20 mesh angular sand or equivalent grit under pressures of 40 to 80 lb. per sq.in. Blasted surfaces should be sprayed within 24 hr. to avoid reoxiding—in fact it is possible to have the blaster and the sprayer work from the same compressor, one following the other right up.

Spraying should preferably be at 90 deg. to the surface, although bond is good, density uniform and deposit economical down to 45 deg. Surfaces have even been coated at angles down to 20 deg. where it was impossible to get the gun in, but apparently an aiding factor in these cases was the tendency of the air blast to curve upon striking the obstructing surface and to carry some of the ricocheted particles onto the surface to be coated. Normally, at angles below 45 deg. deposit becomes porous and non-uniform, bond is poor, and too much material is lost by ricochet or bouncing off. Special nozzles, either the fan type, angle or rotating extensions will often solve bad angle problems.



Spraying a 0.010-in. stainless steel coating on a valve plug

Although guns are available in all sizes to spray a wide variety of weights of metal in a given time, it is best to use the finest spray consistent with economy, for it penetrates and bonds better. Coats are applied by passing the gun over the surface just as in spraying paint. Ordinarily there is enough distinction between coats so that the operator experiences no difficulty in seeing where previous coats have covered. Successive coats should be applied, where possible, by alternating the direction of the passes, so that the coats build up as a criss-cross network. When spraying on metal, the object should be at room temperature, otherwise condensation of moisture from the air may damage the bond.

Costs

With $\frac{1}{8}$-in. rods which can be applied at 6 lb. per hr., total cost including metal, ogygen, acetylene and labor will run $0.50 per lb. for cheaper steels such as Norway, cold-rolled and high-carbon, $1 a lb. for stainless steel or Monel. A pound of metal covers a square foot of surface 0.025 in. thick. With an 0.006-in. coating, material cost per square foot is: iron $0.18, lead and zinc $0.11, aluminum $0.90. Sandblast or gritblast can be estimated at $0.03 to $0.05 per square foot. Of course there are a number of variables which prevent any really accurate estimate of costs, such as variations in set-up time, difficulty of reaching surfaces, difficulty of preparing, "edge" loss (which is important when small or narrow pieces are coated), cost and difficulty of getting materials, gases and labor. Perhaps some examples of work actually performed will come closer to presenting a true picture.

On the carbon-steel valve plugs, 5 in. in diameter by 12 in. long, of several hot-oil pumps, a stainless steel coating 0.010 in. thick was applied to resist corrosion. Spraying time was 10 min., $\frac{3}{4}$ lb. of $\frac{1}{8}$-in. stainless wire was used, and 8 cu.ft. each of oxygen and acetylene. No finish machining was required because none of the sprayed surfaces were bearing surfaces.

A Monel metal pump shaft $1\frac{7}{8}$ in. in diameter was coated for 12 in. of its length $\frac{3}{16}$ in. thick with Monel, then machined to size. Two hours was required, including machining, and 4 lb. of $\frac{1}{8}$-in. Monel wire, and 35 cu.ft. each of oxygen and acetylene.

Two bronze pump sleeves, 2 in. in diameter were tapered and badly worn. For the two, $4\frac{1}{2}$ lb. of $\frac{1}{8}$-in. Monel wire, and 42 cu.ft. each of oxygen and acetylene were required. Spraying time was 50 min. These sleeves have been rebuilt several times with entirely satisfactory results.

This process is no more a cure-all than any other. Here's a job on which it failed: A 7x42-in. reciprocating pump plunger pumping oil up to 1500 lb. pressure under temperature variations from 50 to 800 deg. F., if of carbon steel failed after 6 months, if of stainless steel lasted somewhat longer. Three carbon steel plungers were built up with chrome-manganese steel $\frac{1}{16}$ in. thick. All three failed within four months in such a manner that differences in coefficient of expansion were apparently responsible. The same treatment was tried on the stainless steel plungers, with the same result, and the problem has not yet been solved. But, paradoxically, in Pennsylvania, large bronze pump plungers are being rebuilt with stainless to operate at temperatures to 1200 deg. F. The only precaution there is to weld a bronze bead around the head end of the plunger and to undercut it before spraying.

A large West Coast utility found the needles in several impulse waterwheels corroded at the sliding contact through a support and guide bearing. They were turned down $\frac{1}{32}$ in. and built up with stainless steel. The result was cheaper than a shrunk-on bronze sleeve and better.

A cast-iron pump case was sprayed inside and on the wear ring bearings with stainless steel $\frac{1}{16}$ in. thick. The cavitated bronze rotor was filled and brought to size with sprayed-on Monel, and the shafts built up with Monel,

(Continued on Page 700)

WHEN YOU RENEW YOUR INDUSTRIAL POWER CONTRACTS

A HUDDLE MAY HELP

INDUSTRIAL power contracts cover such a wide range of conditions that it is easy to overlook many important points if renewal negotiations are conducted under pressure from other manufacturing problems. It should be some one's responsibility in every factory to maintain contact at all times with the power-supply situation. If the plant is too small to support an engineering organization or technically qualified employee, an outside specialist should be retained from time to time, or carried on an appropriate fee basis, to check power cost in relation to demand and amount of energy consumed, factory output, variations in cost of purchased power and other service furnished by utility systems, accuracy of billing and general observance of contracts. If the outputs and power bills run along without marked variations for considerable periods, there may be no necessity for such skilled regular scrutiny; but when renewal time approaches the picture changes.

Utility power-sales engineers with few exceptions are unusually high-grade men, competent analysts of power economics and worthy of much confidence. In innumerable cases they have shown themselves capable of appreciating the factory's power problems, the opportunities for reducing wastes of energy and excessive demands, and the advantages of better manufacturing methods. Nevertheless, the ability to meet such specialists on equal terms across a conference table is an asset of no mean value to industrial power users. To have at hand the major points bearing upon costs and service in such discussions is very advantageous, even if many phases of the power supply question are absent in a particular negotiation.

Skilful buying is as important in power supply as in many other matters, and the fact that in many industries power represents but a small percentage of manufacturing cost should not be allowed to minimize the weight of total dollars spent for power. In these times a dollar properly saved in one place is as good as one salvaged anywhere else.

Elements of Contract Renewal

One would hesitate to set forth a list of elements underlying contract renewals as applicable to and complete for all classes of power service. At the same time the background factors are widely suggestive in a recent negotiation for utility service renewal conducted by a metal-working plant in the persons of its operating vice-president and its outside consulting engineer with the power sales engineer and the vice-president of the utility.

In this situation, rising costs of manufacturing sharpened the desire of the customer for a concession in electric rates. The utility, on the other hand, was bound, if possible, to retain the valuable patronage of this mill and desired to make a fair profit on the business. There was little advantage to the industrial customer apparent in the abandonment of utility service and production of power in an isolated plant, or in a combination of the two, according to preliminary studies.

Renewal was effected on terms which both parties declared satisfactory, and this result was made possible in large measure by the fact that the four conferees weighed the various elements of the problem together, taking up each point and devoting time to it in proportion to its importance. The agenda of the conferences follows, with the addition of a few points covered in another conference where a factory was prepared to sell surplus power to the utility on occasions.

IN POWER CONTRACT DISCUSSIONS SETTLE THESE POINTS:

1. Agreement that legal departments shall pass on completed draft of new contract, draw up final form and submit to executives for approval.
2. Definitions of terms, including: demand, peak hours, off-peak operation, primary power, secondary power, surplus power, industrial feed-back power for sale to utility, connected lighting, power and heating loads.
3. Specification of points of delivery, phase of energy supplied, voltage and frequency variations permissible.
4. Statement of demand provided for and provision for increased power supply in the event of business expansion. Terms under which additional capacity will be supplied for stated periods.
5. Consideration of guarantees of minimum demand to be paid for by customer, and allowances for reduced central station plant, line and substation capacity in case the customer's business diminishes.
6. Definition of boundaries of ownership of plant involved in electric service.
7. Amount of spare transformer capacity to be provided in substations.
8. Facilities for protection against lightning.
9. Agreement as to power-factor penalties, bonuses and neutral zone for use in billing. Discussion of responsibility for investment and operation of future power-factor corrective equipment, and its location.
10. Discussion of price to be paid per kilowatt of demand and per kilowatt-hour consumed. Due weight to be given to proposed increase in feeder facilities and substation capacity to meet new conditions in factory. Parties to jointly analyze cost of providing additional facilities. Basis of feed-back power sales to utility.
11. Metering facilities for light, heat and power services.
12. Provision for checking meter calibrations and periodic requirements in testing.
13. Billing arrangements and payments.
14. Discussion of coal and oil price clauses, and of relation of hydro-electric power purchases by utility to kilowatt-hour prices.
15. Provisions for arbitration, cancellation, periodic survey of contract, and its renewal or modification.

SIMPLE AIR RELIEF
SERVES EMPIRE STATE

WHEN steam is shut off from some heating zones in a large building, air will get in, no matter how tightly the system is maintained. When the steam is turned on again in the morning, it often requires an hour or more to clear the system because of the small capacity of the air traps. This means a much higher steam pressure, slower and unequal heating, for naturally the sections first cleared of air heat first.

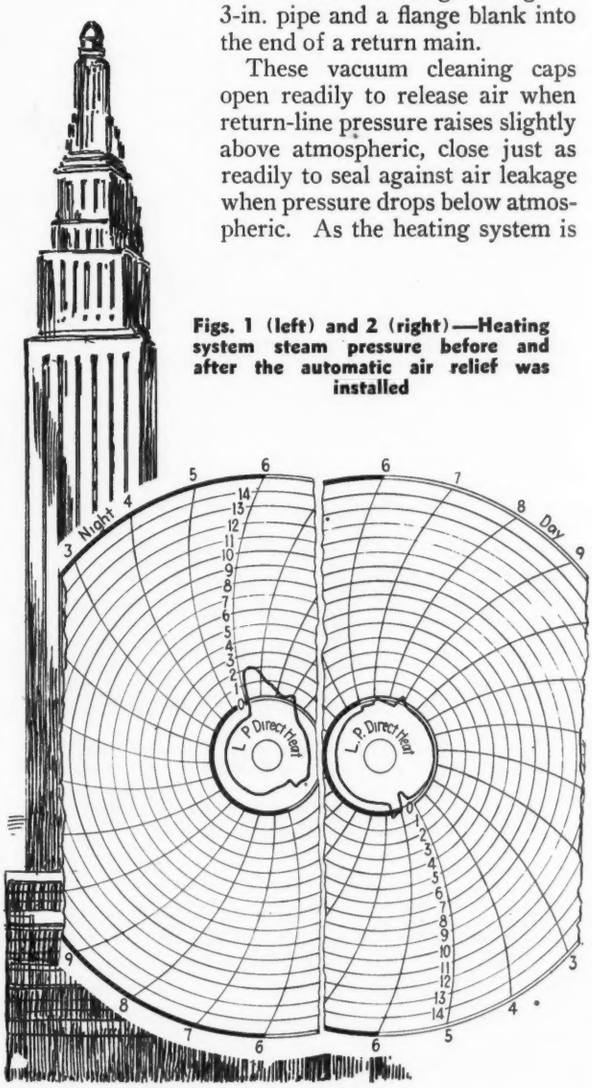
C. F. Wendland, chief engineer of the Empire State Building, New York, N. Y., found through study that a considerable steam saving would result if the heating system could be quickly cleared of air. The result was an automatic relief device, Fig. 3. Three central-vacuum-cleaning system hose adapters were tapped into a section of 4-in. pipe which had its bottom end capped and tapped for a 2-in. pipe. A fourth vacuum-cleaning hose adapter closed the bottom end. The top end of the 4-in. pipe is screwed into a 4- to 3-in. reducer leading through a 3-in. pipe and a flange blank into the end of a return main.

These vacuum cleaning caps open readily to release air when return-line pressure raises slightly above atmospheric, close just as readily to seal against air leakage when pressure drops below atmospheric. As the heating system is generally operated under vacuum except when starting in the morning, the air relief is sealed most of the time.

It is possible that a water slug might come over into the air-relief system, a contingency which is provided for by the lower cap, which discharges it to a funnel and thence to the sewer.

Figs. 1 and 2 show charts of heating system pressure before and after installation of the automatic relief. Fig. 1 records a 15-deg. day, with steam turned on in the morning at 2-lb. gage. Pressure did not drop below atmospheric until 9.30 A.M. Fig. 2, on the contrary, shows a 23-deg. day, but even with a considerably lower outside temperature, heating system pressure stayed below atmospheric except for two 15-min. periods in the morning and evening. The evening rise is abnormal, and need not be considered, as it was caused by a special need for higher pressure for a short time. Fig. 2 shows the heating system freed of air in the morning even while apparently under a slight vacuum. This is caused by the falling of sufficient condensation down the vertical return lines during heating up periods to raise the pressure and force air out of the relief valves.

Before the relief valve was installed, steam was turned into the heating system in cold weather at 5 A.M. With the quicker heating under the present system, steam will probably not have to be turned on until an hour later.



Figs. 1 (left) and 2 (right)—Heating system steam pressure before and after the automatic air relief was installed

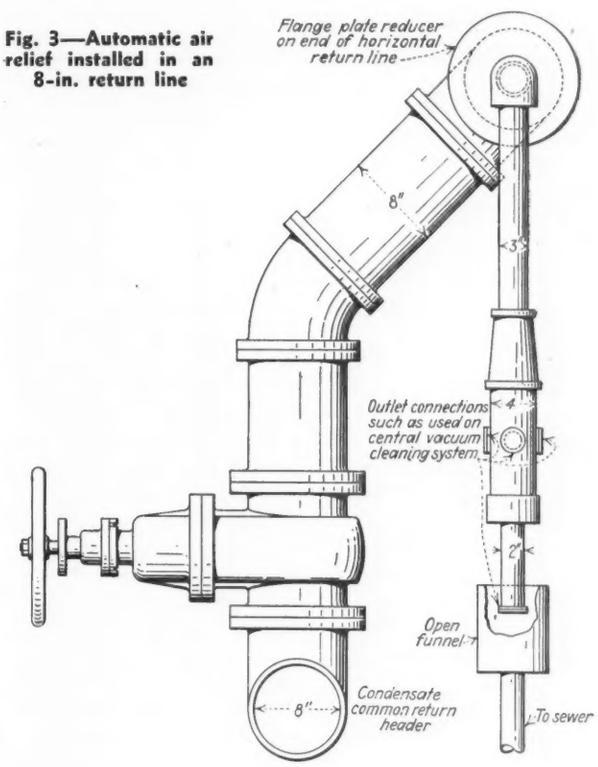


Fig. 3—Automatic air relief installed in an 8-in. return line

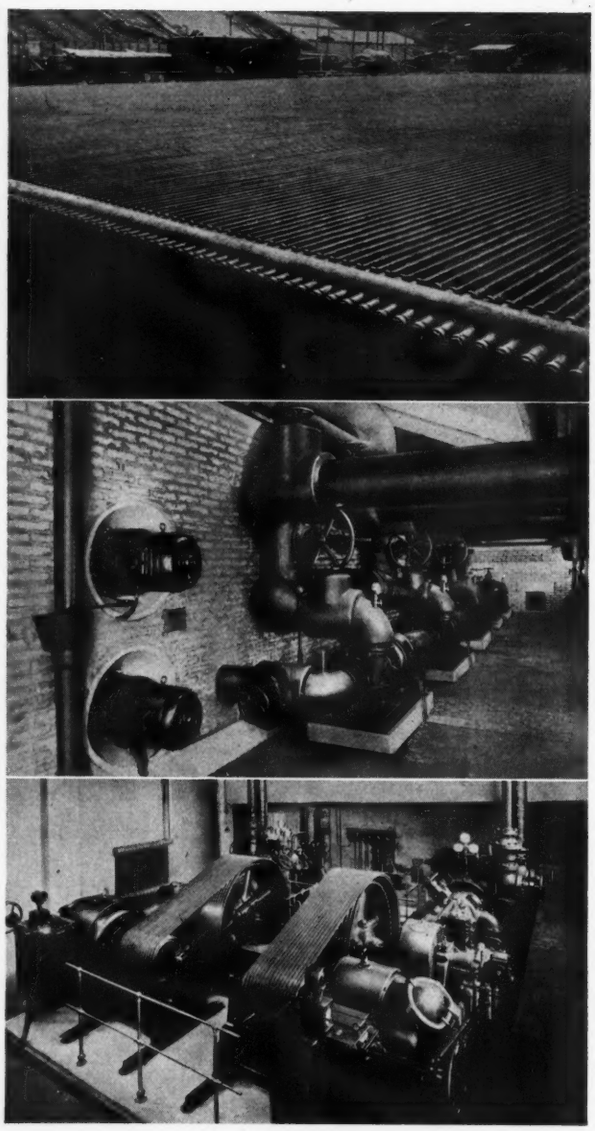
ACRES OF

In the shadow of the Alps, 51 miles of copper tubing underlie Basle's 1½-acre open-air skating rink. Extreme operating economy is obtained by storage of cold. Other features: multiple V-belt compressor drive for quiet, individual tube isolating connections

SKATING on thin ice has never been popular. Therefore, if thin ice is to be avoided on outdoor artificial rinks despite blazing sun or warm breezes, and the owner's profits are still not to be frozen up, it behooves the designer to take considerable care. If he skates on thin ice, so do the skaters; if he assures the skaters ice that is too thick, the owner goes in the hole.

Basle, Switzerland, planned a new skating rink, largest in Switzerland, probably largest in Europe. Instead of the small differences between evaporating and liquefying temperatures of the refrigerating medium which are normally expected in this type of plant supplying refrigeration only in winter, the differences may really be quite large. This, plus the fact that the plant must run almost continuously and still economically through the warm days at the beginning and end of the season, led Sulzer Brothers, of Winterthur, who handled the job, to select 2-stage compressors. They require less power under these conditions than do single-stage units. Two electrically-driven, horizontal, 2-stage, double-acting, 140-b.hp., Sulzer ammonia compressors were installed, each with a rated capacity of 2,000,000 B.t.u. They have stepped pistons, piston rods kept tight by stuffing boxes, water-jacketed high-pressure cylinders, adjustable crosshead slippers moving in cylindrical guides, and working parts totally inclosed for dust and oil tightness. Since only the cylinder interior contains ammonia under pressure (against which the piston rod stuffing box acts), all moving parts are easily accessible. Lubrication is by a centralized force-feed system.

The compressors are in a room under the grandstand. To avoid noise in the grandstand and nearby homes, V-belt drives were installed on the compressors. They have operated almost noiselessly so far. Ammonia vapor is cooled and liquefied in a totally inclosed counter-current condenser. The condenser is subdivided into a series of groups fitted over each other and working in parallel; any group can be opened for cleaning while the rest of the condenser stays in service. Water is individually controlled.



Top—Headers with brine collectors and distributors during erection. Center—Three pumps for circulating brine, and behind them the circulating water pumps. Bottom V-belts drive the two 2,000,000 B.t.u.-per-hr. compressors quietly

Cooling water for the condensers is sent through two circulating pumps to a cooling tower nearby. This reuse of water avoids prohibitive expense, and the trick-

MAN-MADE ICE

ling cooling tower with storage tank, from which water flows by gravity to the ammonia condenser, avoids the noise of a smaller, fan-cooled tower.

Because of the sympathetic attitude of the rink management, a number of innovations were permitted in the system which have made it a model of its kind. For example, much importance was placed upon having a cold-accumulating plant of great capacity—the longer the skating season and the harder the ice on special-event days, the greater the profits. At this rink, storage is attained by cooling the stock of brine in a 14,500-cu.ft. tank. The high-efficiency ammonia evaporators are set into this tank. When brine temperature is lowered 18 deg., the quantity of cold accumulated is about equivalent to that produced by the two compressors operating at rated capacity for 4 hr. Thus, the cold accumulator can be charged during the night or early morning when current can be obtained at cheap rates and the quantity of cold required by the rink is low.

When cold is accumulated in this manner, brine temperature may become much lower than that needed to insure best ice in the rink. Thus brine circulating temperature must be controllable independently of the accumulator temperature. This has formerly required complicated individual adjustment of a number of cocks in the brine piping; at Basle it is done without guesswork by turning a single handwheel. This valve is installed in the machine room with the cold brine circulating pumps and regulators for the pipe-network, thus centralizing control.

The rink itself covers an area of 65,000 sq.ft., and is frozen by a network of 51 miles of copper tubing subdivided into three sections each 590 ft. long and 110 ft. broad. Each section has its own flow and return pipes for brine, thus can be operated independently. This is extremely important at the beginning and end of the season when days grow warmer and skaters fewer, with electricity costs increasing and revenue declining. In order to work the plant economically at such times, part of the rink is shut off, only a third or two-thirds, for example, being kept in skating condition. In each of the three sections also, the direction of brine flow can be reversed. Circulation is handled by three Sulzer centrifugal pumps.

The pipes laid under the ice are of seamless cold-drawn copper instead of mild steel because at the time of purchase the price differential was not prohibitively great, particularly when copper's infinitely greater resistance to corrosion was given due weight. Further, the copper retains its value as a raw material, while the mild steel is soon corroded and destroyed, and is then absolutely worthless.

In order to obtain full benefit of copper's resistance to corrosion, especial care was taken to insure absolutely correct joints. It was essential to avoid attack from brine, electrolytic action or changes in weather conditions. Soft soldering, ordinarily used for this work, has these disadvantages. So welded joints were used, of the same type as those used in steam boilers for pressures up to 2,000 lb. and temperatures of 750 deg. F. and higher.

Particular attention was paid to the design of joints between the copper tubing and the brine distributing and collecting pieces. Rigid joints, which require special expansion bends in pipes or use of jute, rubber or other organic material as a packing, could not be used. Stuffing boxes were preferred to give the necessary play, each fitted with an opening lying opposite the end of the copper pipe and closed with a cap. Through these openings, any pipe could be lighted through and inspected to see that it was clear, and if necessary could be rinsed through separately or tested under pressure for leakage.

ARE YOUR DIESELS MAINTENANCE HOUNDS?

By PAUL M. THAYER

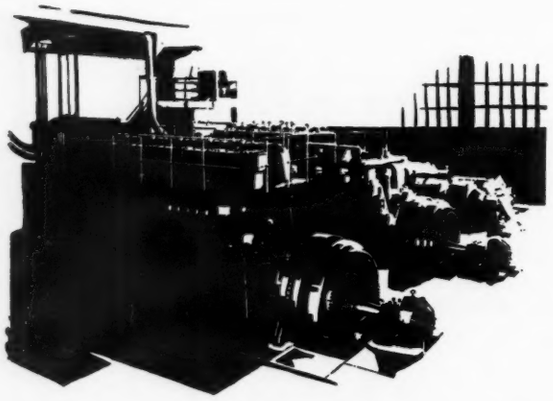
PROBABLY the most discussed and least understood item of diesel power plant costs is maintenance. In making an estimate of the probable cost of producing power with a proposed diesel plant all items of operating cost are readily ascertainable with this one exception. Therefore, it is highly desirable to make as careful an analysis as possible to eliminate guesswork from the anticipated cost sheet as far as practicable.

Many claim that maintenance should include not only the cost of all parts used as replacements, but the labor of installing them and the labor incident to routine inspection, cleaning, etc. However this item of cost is set up, design of the engine has a great deal to do with its magnitude.

In too many instances the diesel designer goes at his task with the idea principally in mind that he must produce a design that can be manufactured at the lowest possible cost per horsepower, giving only secondary consideration to the cost of maintaining that engine in operation. Engines should be designed with economical manufacture as a prime consideration, but low cost of repair parts and ease of making repairs should never be relegated to the background.

Some years ago I made a careful analysis of the repairs sent out to a group of twenty large diesels oper-

ating in the Southwest. Lists were made of every invoice covering parts and material shipped out to these plants over a period of ten to twelve years; these items were all classified by engine part—fuel system, injection air system, fuel valves, bearings, pistons, cylinder liners, etc. These were all summed up and grouped according to age of service and again according to load factor of the plant. The results were surprising, to say the least. It was apparent that certain plants had much more trouble with certain groups than did other plants, and there seemed to be no logic or reason to any of it. This brought out forcibly that other factors besides design had a bearing on the results; also, that certain designs which were highly successful under one set of



conditions gave unsatisfactory results under another.

One point brought out was the relatively high percentage spent for repairs of the high-pressure air system used for fuel injection. This ran from ten to over thirty per cent of the total amount of repairs furnished; the percentage being greater on small units than on larger ones. This high-pressure air system also adds from five to fifteen per cent to first cost of the unit, again depending on the size. Thus the designer can reduce both first cost and maintenance cost by going to solid injection of fuel. There are a few instances where heavy fuel oil is available at a sufficiently lower figure than the lighter oils to more than offset this higher cost of maintenance, as well as the higher initial cost of the plant.

Cylinder liners, piston rings, and cylinder heads all showed what appeared to be excessive replacement requirements. Cylinder heads in particular gave very poor performances in the early years of operation, but in the latter years their life had been increased from an average of less than 1,000 hr. to well over 20,000, with individual heads in satisfactory operation after 40,000 hr. The change from cast-iron heads to cast steel was largely responsible for this improvement in results; nevertheless, it is indicative of the importance of design on cost of maintenance.

Cylinder liners showed widely varying rates of wear, some plants showing ten times the wear of others. This indicates that there were other reasons for wearing out of cylinder walls than just material or design. At first this was attributed to faulty lubrication, and every variety and kind of lubricating oil was tried out with indifferent success. On further investigation it developed that different grades of fuel oils were used in different plants, some of which ran very high in carbon residue and ash, also some engines were operating in a desert country without any means of filtering the air. Finally, the cooling water was depositing scale in the water jackets. When some of these defects in plant design were corrected, the trouble largely disappeared.

One engine with which I am familiar developed trouble with the gears driving the vertical shaft that, in turn, drove the cam shaft. There were many engines of this same type in service, none of which had ever given any particular trouble with these gears. But this one required three sets of gears in a little over two years. They showed signs of serious cutting, and the trouble was first laid to faulty lubrication. Different oils were tried and new oil pipes feeding directly into the mesh of the gears installed; none of these things showed results. Then it was thought that there was a critical vibration in the vertical shaft or the cam shaft, and tests were made to determine this point. Nothing showed up along these lines, nevertheless a heavier vertical shaft was installed and a flywheel was placed on the cam shaft. None of these remedies corrected the trouble. Then one day the designer decided to try to put on gears that had a different number of teeth in the lower set than in the upper set. There was no further evidence of undue wear. Undoubtedly the meshing of the upper and lower gears in unison set up a synchronous vibration that had very harmful results.

Still another engine that came under my observation developed a lot of trouble with the lower step bearing on the vertical shaft driving the cam shaft. This engine was designed so that the vertical shaft could be placed on either side of the engine, and the engine itself made either right- or left-hand. This particular engine had the vertical shaft so placed that both the thrust of the gears and the weight of shaft was downwards, greatly adding to the work of the step bearing. The operators thought that a faultily laid out lubricating system was the real cause of their trouble. They tried to correct it, with no results. The whole thing could have been avoided by running the engine the other way—purely a matter of design.

Too Complicated

A few years ago I made a study of the time required for routine inspection of different types of diesel engines of the same size. One 6-cyl. 4-cycle engine of 600 hp. would require 600 man-hours per year to go over every part properly, whereas another engine of the same capacity, but of the 3-cyl., 2-cycle type would require only 240 man-hours for the same work.

Examples of this kind can be given without end, cases where an engine or plant designer failed to avoid certain trouble or forgot to investigate the actual conditions under which the plant would have to operate.

It is vitally important that anyone responsible for the design of a diesel engine or a diesel engine plant consider the question of maintenance of that engine or plant when he decides on the final layout. This is especially true in view of the present decided trend toward concentration of large powers in small high-speed units; the old figures obtained from plants containing heavy-duty, slow-speed units, expressed in per cent of first cost, will not do at all for these newest types. Time alone can determine what their maintenance costs will be. It is a safe bet that these maintenance costs can be greatly reduced by providing clean air, cooling water free from scale-forming properties, and proper purification of both fuel and lubricating oil.

OILING MADE AUTOMATIC ON FREE-WHEELING CLUTCHES

By C. L. ALEXANDER

OUR forced- and induced-draft fans are dual driven, motors being direct-connected through gear-type flexible couplings on one side, and steam-turbine and gear units driving at the other side through automatic or over-running clutches. But inadequate lubrication of the clutches gave us trouble from the moment the set-up, Fig. 1, was started. We tried intermittent lubrication by grease gun with various oils. That didn't work either, so we decided to design an oiler that would give constant, uniform supply and that would free itself automatically when the turbine was started.

With the clutch taken apart, we found that lubrication could best be applied to the bronze hub bushings, *A* and *A*, Fig. 2, about 30 deg. above the horizontal diameter of the shaft, as at *B*. The hub center is normally at rest, for the turbine is used for emergency drive only. For this reason, three points of oiling are used and the hub is rotated 120 deg. every 24 hr. This tends to equalize wear on the hub and bushings.

Although the diagram, Fig. 2, is self explanatory, there are a few special points about the installation that should be mentioned. The oiler is mounted on a tube passing through a pivoted block *D* supported by a plate extending from the top of the reduction-gear housing. A spring on the oiler tube below the pivot block prevents overstressing of pipe *E* when the oiler is set. The pipes are also stayed by the light ring *F*. Machined surfaces are provided on the outer ends of the standard ⅛-in. 45-deg. elbows on the end of pipe *E* to fit into the conical end of the oiler tube, thus providing a dust-proof connection.

The two pipes not in use are sealed by leather washers and capscrews. Counterweight *W* is suspended from pivot block *D* to tip the oiler off vertical as soon as the steam-driven half of the clutch moves. The oiler must, of course, be reset after each run of the turbine.

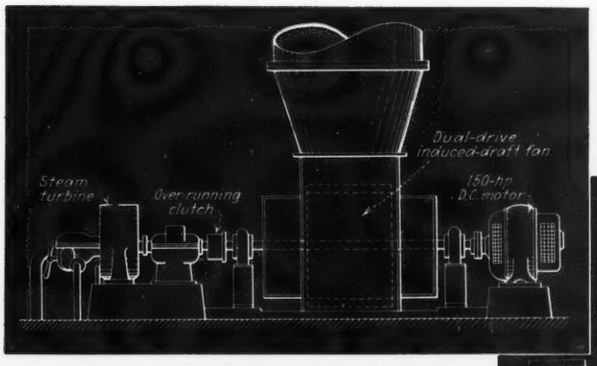


Fig. 1 (Above) — Set-up of induced-draft fan driven by turbine and gear reduction and through free-wheeling clutch or by motor through flexible coupling. With simple oiling, this arrangement gave trouble

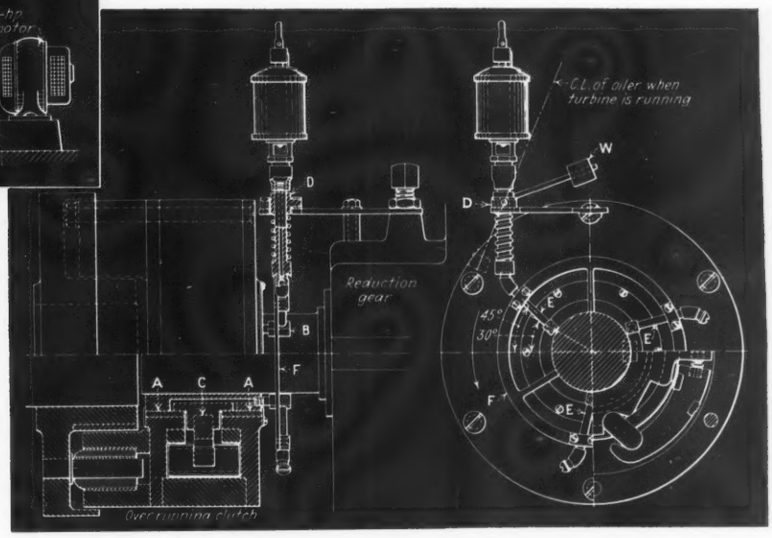


Fig. 2 (Right)—Section through the over-running or free-wheeling clutch, showing the special oiling device developed to meet the specific conditions

Novel Dutch Ash Catcher—Dutch experiments with an ash catcher of Netherland origin have shown interesting results. An Economic and Trade Report of the Dutch Institute for Fuel Economy, sent to *Power* by the Machinery & Agricultural Implements Division, Department of Commerce, reads:

"Investigation of an ash catcher of Netherland origin, partly filled with water, through which spiral blades revolve on a rotating axle, moisten and catch the ash floating in the air. The catcher was placed behind a Lancashire boiler with a heating surface of 537 square feet and in which fine anthracite and pressed coal were used as a fuel, in the proportion of 3 to 1. Per hour 305 lb. of fuel were consumed. The catcher consumed 3,036 lb. of water, in which 6.6 lb. of ash were found.

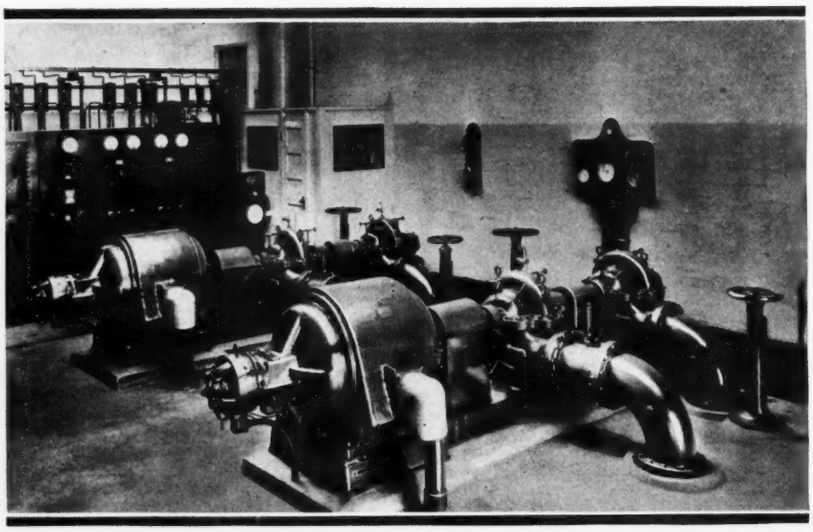
"It was found that slightly over 50 per cent of the ash taken from the flue before the catcher, remained on a fine screen (400 meshes per square millimeter). Only 6 per cent of the ash after the catcher remained on the sieve."

REPLACE, DON'T REPAIR

AND YOU'LL SAVE PUMP MONEY

By FRANK A. KRISTAL
Mechanical Engineer, New York, N. Y.

New pumps sometimes pay for themselves in less than a year by cutting power costs. Occasionally, new pumps cost only a fraction more than thorough repair of the old ones. It will pay you to investigate.



Two fresh-water supply pumps driven by 250-hp. 1,800-r.p.m. synchronous motors

GREAT improvements have been made in pumps, particularly the centrifugal types, during the last ten or fifteen years. These improvements are so outstanding that they make it economical to replace old pumps with new ones in many installations. Comparison of efficiency of old and new centrifugal pumps shows that the power saving possible will soon pay for new pumps.

Fig. 1 shows characteristic curves of a 6-in., single-stage, double-suction, centrifugal pump supplied by one manufacturer as standard equipment ten years ago and those for a modern pump of the same manufacturer for similar conditions. Each pump is rated at 1,300 g.p.m. against a 200-ft. head when operating at 1,750 r.p.m.

The old pump has an efficiency of 73 per cent when operating under rated conditions and requires 90.3 hp. to drive it. The new pump gives an efficiency of 84 per cent and requires only 78.5 hp., an 11 per cent increase in efficiency with a 13 per cent reduction in power. This is a power saving of 8.85 kw.-hr. for each hour that the new pump operates.

Assuming a power cost of 2c. per kw.-hr. and 3,000 hr. operation per year, the saving in power cost would be $8.85 \times 3{,}000 \times 0.02 = \$531$. Since the new pump costs under $700, it will pay for itself in less than a year and a half.

Efficiency Up 16 Per Cent

Characteristic curves of another manufacturer's pump, tested in 1926, compared with those of a pump built in 1932, and tested under similar conditions, are given in Fig. 2. Each pump was designed for 4,000 g.p.m. against 194 ft. total head. The old pump has 75 per cent efficiency, the new 91 per cent, an improvement of 16 per cent.

The new pump shows a power saving of approximately 32 kw.-hr. per hour of operation. If operated under the conditions given for the pumps of Fig. 1, a saving of $1,920 per year will result. To savings due to higher efficiency of the new pump should be added those from reduced maintenance costs and higher sustained efficiency. All these make an investment in the new pump unusually attractive.

Improved Design

A report of the chief engineer, U. S. Reclamation District No. 1500, to the board of trustees is an outstanding example of reduction in pumping cost that may be made by modernizing. Average power cost per year to operate the old plant from June, 1926, to June, 1929, was $47,491. A new plant went into service on the latter date. During its first two years' operation power costs were reduced a total of $62,593.81. This represents a large part of the total investment of $70,000 for the new plant.

Fifteen years ago small capacity against high head required using either a reciprocating pump or a multistage centrifugal operating at a comparatively low speed. Such applications, for heads up to several hundred feet, now can be readily served by high-speed single-stage units. Fig. 3 gives characteristic curves for a turbine pump rated at 60 g.p.m. against a 200-ft. head at 1,750 r.p.m. Such pumps are available in capacities of from 0.5 to 350 g.p.m. and for heads up to 300 ft. in a single stage.

High efficiency of centrifugal pumps has been obtained by improved designs of impellers, better propor-

tioned water passages, suction and discharge nozzles. Combined with their higher efficiency, new designs of centrifugal pumps are superior mechanically to older types. Bronze and other materials now used in construction resist wear and corrosion better and also contribute to superior performance.

Since operating costs of a pump during its life may be many times its first cost, it is important that pumps be selected that have high efficiency and that will maintain their efficiency over a long period. Materials in well-designed pumps are selected with this object in view. Modern pumps are more readily accessible than earlier designs, and this promotes their reliability. A pump that can be easily taken apart for inspection is more likely to be kept in good condition than one difficult to get into.

Present-day pumps usually run at higher speeds, have fewer stages for a given head and are more simple in construction than their predecessors. This results in more accurate machining and lower first cost for the pump and for spare parts when required. Recently, when I discussed this feature with the sales manager of a large pump company it developed that frequently a new pump will cost less than a rotating element for a pump 15 yr. old.

Whenever old pumps require extensive repairs, careful consideration should be given to replacement. Their repair cost is a credit if a new pump is purchased, which combined with better performance of the latter makes its purchase doubly attractive. A recent price made on two new pumps to replace two old ones that had to be repaired, was only slightly higher than a quotation for repairing the old units. The old units each comprised a separate pump and motor coupled together on a bedplate and ran at 1,750 r.p.m. Pump and motor are built as a unit in the new design for a speed of 3,525 r.p.m., consequently their dimensions are much smaller than those of the pumps they are to replace. Because of their superior performance, the new pumps require 3-hp. motors to drive them, as compared with 5-hp. motors installed to operate the old pumps.

For Special Service

For special services, such as handling materials, modern centrifugal pumps are superior to older designs. For example, in pulp-and-paper manufacturing new centrifugal stock pumps have 10 to 15 per cent higher efficiency than old types still in use. Besides a large increase in efficiency with new stock pumps, they are decidedly more accessible and less likely to clog, are easier to clean, have few parts to replace and have lower first and maintenance costs for a given size. The new pumps will also handle a higher percentage of stock than the older types.

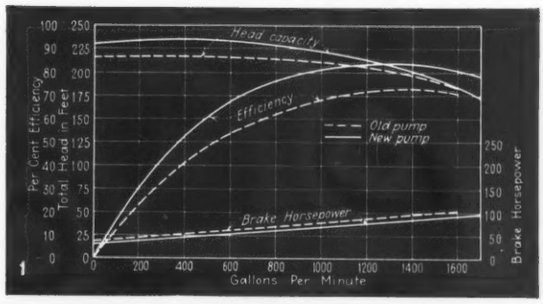
For sewage work early designs of centrifugal pumps were practically the same as those used for pumping water, except they were oversize units with slow-speed impellers to prevent clogging. Such pumps were not only difficult to inspect and repair but had low efficiency, usually below 60 per cent. Modern sewage pumps are specially designed for the service. They have non-clogging impellers with large clearances to pass solids. Handholes are provided at the suction for easy inspection and cleaning. They have 10 to 15 per cent better efficiency and are designed to avoid the frequent and expensive repairs prevalent with old designs.

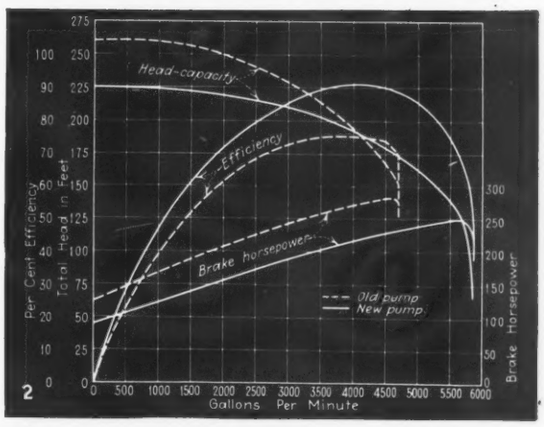
Reciprocating pumps in good condition have a high efficiency. When they are steam driven and exhaust to atmosphere they may be expensive to operate. Where these conditions exist, economic reasons are just as favorable for replacing them with a motor-driven reciprocating or a centrifugal type as they are for replacing an old centrifugal unit.

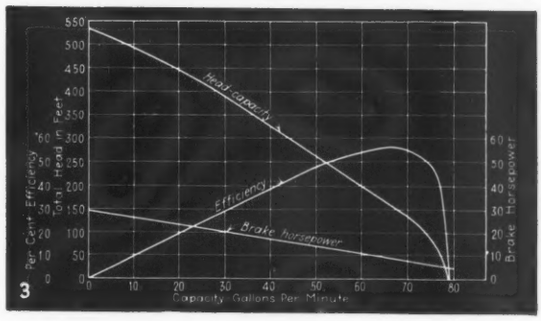
Probably no piece of equipment in a plant offers greater possibilities for return on its investment than does replacing an old pump with a new one. Engineers may point with pride to the old pump that has been in service for 20 years and still gives a good account of itself. As a sound business proposition, however, it may be far more economical to junk the old pump and install a new one.

The author gratefully acknowledges assistance rendered in preparation of this article by Allis-Chalmers Mfg. Co.; Byron Jackson Pump Mfg. Co.; American Well Works, Westco Pump Co.; and Weinman Pump Mfg. Co.

Fig. 1—Characteristic curves for a new and an old 1,300-g.p.m. pump for 200-ft. head. Fig. 2—Characteristic curves for a new and an old 4,000-g.p.m. pump for 194 ft. head. Fig. 3—Characteristic curves for a modern turbine pump rated at 60 g.p.m. against a 200-ft. head





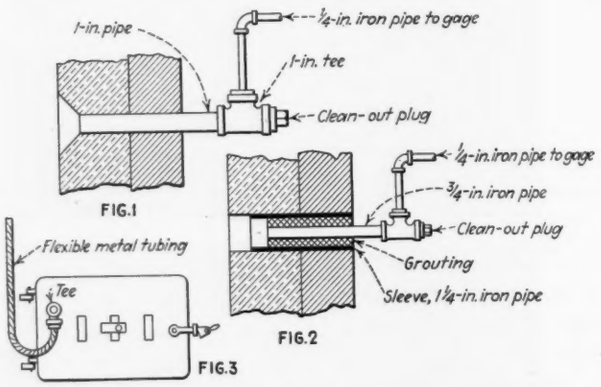


DRAFT-GAGE CONNECTIONS

THAT PREVENT TROUBLE

By CHARLES C. PHELPS

DRAFT-GAGE connections are often made in ways that invite difficulties, especially from soot stoppage. This can be avoided easily by care in laying out the lines. Where the furnace-draft line penetrates the boiler side wall, the pipe should be 0.75 or 1 in. in diameter with a tee on its outer end. The center connection of the tee should point upward, with a plug in its outer end for cleaning, as in Fig. 1. As there is practically no flow in draft-gage connecting lines, the main line to the gage need be no larger than $\frac{1}{4}$-in. standard iron pipe. This line connects to a bushing in the center outlet of the tee as shown. Such an arrangement prevents soot and cinders from entering the $\frac{1}{4}$-in. line, which would be the case if its line ran downward from the tee. The line running through the furnace wall clears the inner surface by 2 to 3 in.



Figs. 1 to 3—Methods of making draft-gage connections

to prevent burning or collapsing of the end of the pipe. The inner end of the hole in the furnace lining may be flared, as in Fig. 1, to prevent cinders from entering the draft line.

Fig. 2 shows a somewhat similar arrangement, but with a $\frac{3}{4}$-in. draft pipe placed within a piece of $1\frac{1}{4}$-in. iron pipe. The space between the two pipes is filled with mortar or other suitable material. Where the line to the gage is long, $\frac{5}{16}$-in. copper tubing may be preferable to iron pipe, because of the ease of erecting it and keeping it tight.

Usually furnace draft is measured at a point near the center line of the furnace proper. With locomotive-type boilers, which have a water leg, it is sometimes difficult to make a suitable connection into the furnace. When a new boiler of this type is bought, it may be ordered with a draft pipe extending through the water leg to the furnace. Sometimes it is possible to use a hollow stay-bolt for the draft connection. Where neither of these arrangements is feasible, a piece of flexible metal hose through a hole in the firing door may serve for the connection, Fig. 3.

Use Smaller Pipes

When connecting draft or pressure lines to ducts, windbox zones, exit-gas passages, etc., smaller pipes may be used than for the furnace reading, because such lines are less subject to soot stoppage. Pipes $\frac{1}{4}$ in. in diameter may be used for such connections and should extend preferably about one-quarter way across the gas or air passages, or into the passage for at least several inches. Aspirating or pressure effects at such points, which result in false readings, may be avoided by placing the pipes so that they are about at right angles to the direction of gas or air motion.

To prevent possible entrapment of condensate in cold boiler rooms, the piping should slope slightly toward the draft passage. When the gage is connected, care should be taken not to make the connection so rigid that it may force the gage out of plumb and cause an error in the reading. Sometimes a short bent piece of tubing connecting the gage and draft pipe will prevent such strains.

Each connection should be provided with a non-sticking shut-off cock near the gage, for checking zero. When such cocks are omitted, the line must be disconnected to check for zero, a bothersome procedure.

1,300-lb. Boilers Show High Availability—Further proof that the availability factors of high-pressure installations, when properly designed, are as good as those of moderate pressure, is to be found in the record of Boiler Room No. 3 at Lakeside Station of the Milwaukee Railway & Light Co. This boiler room contains four units operating at 1,300 lb. steam pressure and 750 deg. F. steam temperature. The first unit was installed in 1926 and the others in 1929 and 1930. Disregarding the first unit, which because of the superheat and reheat arrangement is slightly less flexible, the average availability for the three later units for the year 1933 was 98.1 per cent. The number of times these boilers were banked during the year were, respectively, 224, 230 and 233, and of the time the units were actually out of service only about 60 per cent was chargeable to maintenance.

These units are of the bent-tube type, rated at 250,000 lb. of steam per hr. but operated at times up to as high as 350,000 lb. They are fitted with radiant-type superheaters and fired with a bin-and-feeder pulverized coal system, with the mills directly in front of the boilers and coal dried in the mills by waste flue gases.

Sleek

SURFACES smooth as glass and areas of welded stainless-steel armor this sleek, 42,500-hp. Safe-Harbor runner against its arch-enemy, cavitation. The profiler at right milled the five cast-steel blades, the first time such methods have been used in the United States. A tracer on the full-size template above guides the cutter across a blade mounted below. Before machining, stainless steel is welded into chipped-out sections along the blade periphery, the outer under edge, in a large area beneath the trailing edge and in a triangular section on the upper entering edge. Some of the welded areas and polished surfaces show up in the photograph below

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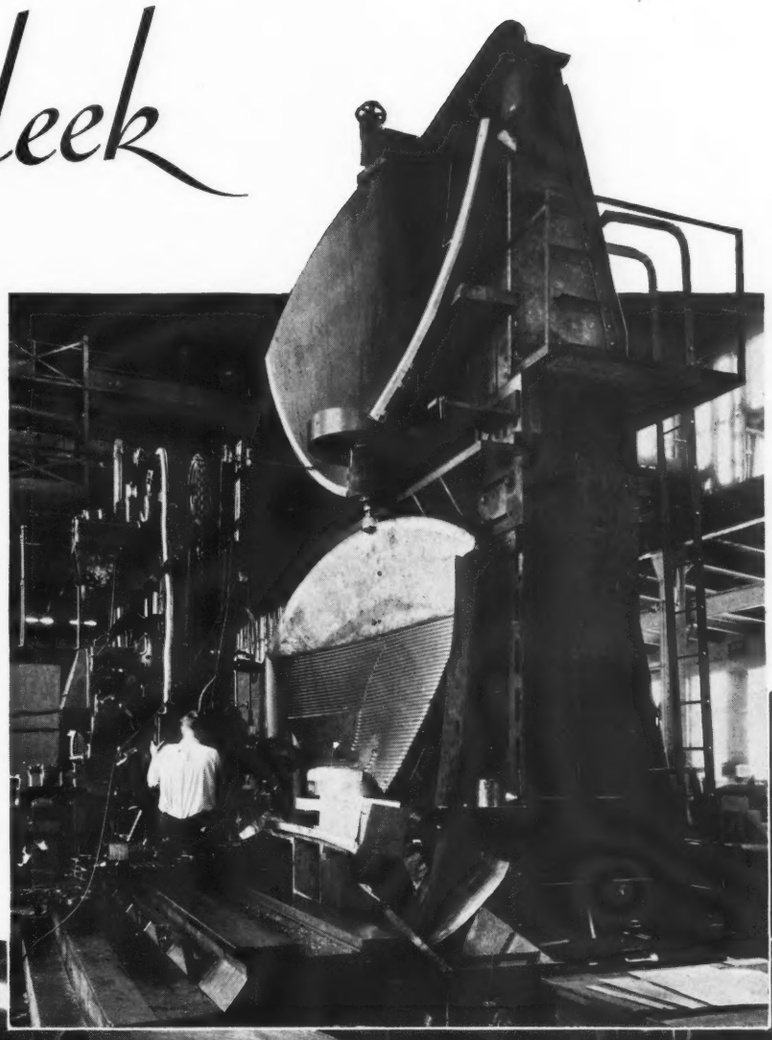
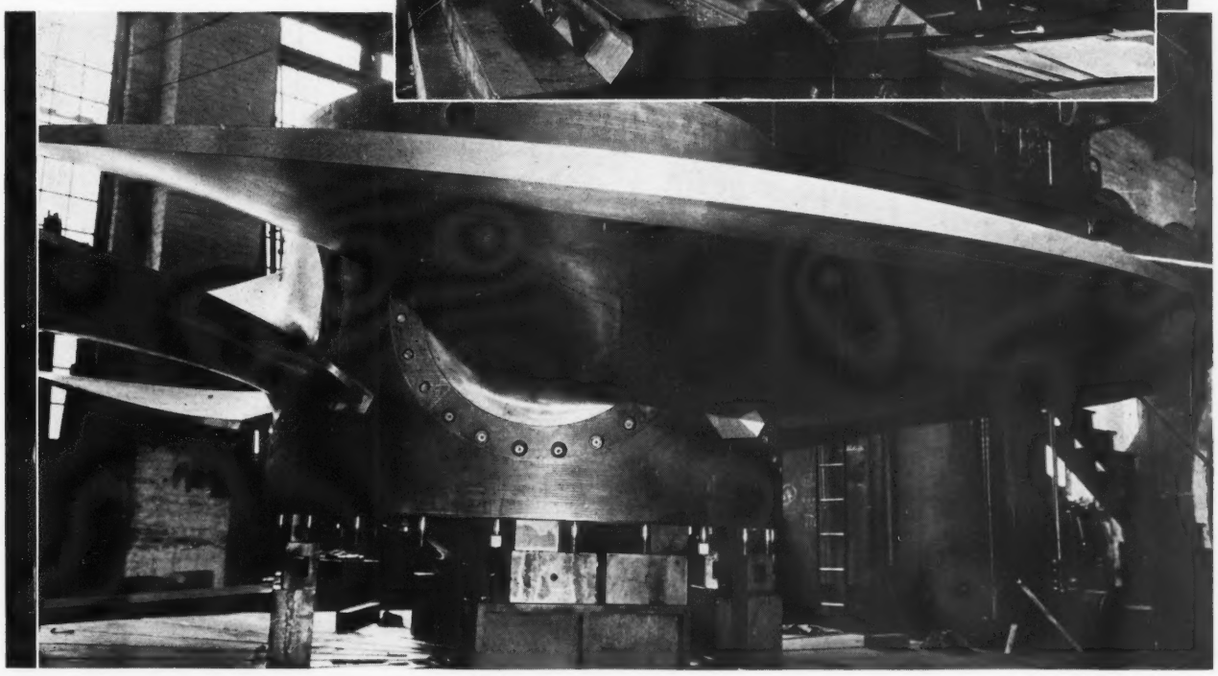


Photographs courtesy
S. Morgan Smith Company



Meet . . .

. . . the five industrial power engineers who discussed so ably for you the functions of the power executive. They speak from a rich background of experience. We'd like to have you meet and talk with them personally, but failing that—here they are

F. M. GIBSON
"Responsibilities and Men"—Page 650

BORN in Dover, N. J., in 1877, F. M. Gibson was graduated in turn from Stevens Preparatory School and Stevens Institute, from the latter with a degree of M.E. in 1901. As a student Mr. Gibson was a good athlete, the studies in which he excelled being football, baseball and lacrosse. * * * After graduation he spent two years in the Chief Engineer's Office, Cambria Steel Co., then two years with San Carlos Copper Co. in Mexico. 1905 found him back in New Jersey as foreman engineer for American Sugar Refining Co. In 1910, the company promoted him to plant engineer of the Boston plant. Seventeen years later he returned to Brooklyn to take his present "sweet" job—plant engineer of the Brooklyn, N. Y., plant of American Sugar Refining Co. * * * Mr. Gibson's society activities make a sizable biography in themselves. He helped organize the Plant Engineers' Club of Boston and served several years as its president, served one year as chairman of the Affiliated Technical Societies of Boston (now known as the Engineering Societies of New England). As chairman of the A.S.M.E. Boiler Code Committee Sub-committee on Care of Power Boilers in Service, he helped to write the code on that subject. He "put over" the first Industrial Power Session at an A.S.M.E. annual meeting and was the first plant engineer (so far as we are aware) to serve on the executive committee of the A.S.M.E. Power Division. A member of the committee for six years, he was also its chairman for a year. He organized the Industrial Power Group, is a member of the joint committee of the A.S.M.E. and the A.I.M.E. for determining standard values of fuels, and is acting chairman of the Joint Engineering Committee on Public Affairs in the New York District. He has written several articles for **Power** and **Industrial Engineering.** * * * In spite of all this, or perhaps because of it, Mr. Gibson still is fond of athletics (his pet sport today is surf bathing) and is a member of the Executive Committee of the Stevens Institute Alumni Association. A good story will find him a ready listener, a good smoke a willing puffer.

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J. HOWARD CATHER
"Keep Records"—Page 656

THE fine art of writing should come natural to J. Howard Cather, for he is a cousin of Willa Cather, famous authoress (Have you read her "Death Comes to the Archbishop" and "A Lost Lady"?) and both were born in the little town of Red Cloud, Nebraska. It is hinted that when J. Howard was a likely lad of three or four, he was taken in tow by the authoress-to-be. Possibly his rebellion against this literary dictatorship drove him into engineering in self defense. But one's blood cannot be denied so completely, so Mr. Cather supplies power to an industry which has been a godsend to authors, and now even has consented reluctantly to become a co-author himself. Mr. Cather early chose that exact science, engineering, for his work. With the exception of a short period of service as a first lieutenant of engineers during the World War, he has been with the Engineering and Power Departments of Eastman Kodak Company for 22 years—in fact, ever since his graduation from Massachusetts Institute of Technology in 1912. Today he is assistant superintendent in charge of the Power Department of the Kodak Park Works at Rochester, N. Y. When you drop into the neighborhood movie to see Mae West, Clara Bow, or what-have-you, the chances are nine to one that the celluloid and emulsion which bring Hollywood to your doorstep were processed by heat, power and refrigeration generated and distributed under Mr. Cather's watchful eye and accounted for by his scores of recording instruments and model cost-keeping system. Remarkable for the size of its refrigerating and water-pumping units, this plant has been selling a somewhat larger amount of power each winter to the local utility than it purchases during the summer. * * * Mr. Cather is a member of the American Society of Mechanical Engineers and the American Society of Refrigerating Engineers.

EDWARD H. BARRY

"Plan Operation"—Page 654

LICENSED engineer, inventor, author, amateur astronomer, A.S.M.E. member, exceptionally able musician, Edward H. Barry is supervisor of power for West Virginia Pulp and Paper Company, in charge of design and construction of power plants. Responsible for efficient generation and utilization of steam and power in the many plants of his company, he daily faces problems in heat balance, design of regulating and control devices, conditioning of boiler water, providing of clean steam, supervision of power cost accounting. His inventions include regulating devices for steam turbines, boilers and auxiliaries, a recently patented water-circulation control system for boilers. * * * A B.A. and a B.S. from Harvard and an S.B. from M.I.T. were followed by a period of designing jute machinery, selling power equipment, Army machine gun expert, Navy lieutenant and teacher. After the War, he became assistant superintendent of Buffalo Weaving & Belting Co., where his penchant for inventing showed up in improvements to textile machinery, then on to become manager for a big button manufacturer in the West. He became associated with his present firm in 1927. * * * One outstanding work which he designed and supervised is the installation of two large steam-generating units at his company's Covington, Va., and Luke, Md., mills. These are both built for more than 600 lb. pressure and 700 deg. total steam temperature and are capable of producing almost a half million pounds of steam an hour. One has a slag-tap furnace, and the two are perhaps the largest units in the country to be placed in operation in 1934. * * * All of Mr. Barry's activities are not confined to his profession. He has constructed his own 6-in. reflecting telescope, is author of a standard treatise on 3-cushion billiards, co-discoverer with Dr. E. M. Frankel of a new process for silvering optical glass.

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ALFRED J. VAKSDAL

"Manage Maintenance"—Page 652 and "Keep Records"—Page 656

LAND of the Midnight Sun and the Vikings, Norway is also the birthplace of Alfred J. Vaksdal, plant engineer, Corning Glass Works. Graduated from Bergen High School and in 1907 from Horten Tekniske Skole in marine engineering, Mr. Vaksdal spent three years with Thune's Mekaniske Verkstad, one in the shop, two designing hydraulic power machinery. * * * In 1910, he sought his fortune in America, first going to Chicago as a designer of steam specialties, tools, laundry and brewing machines. Five years later he laid out a garbage reduction plant for the city. During 1916 to 1919 he was chief engineer for American Briquet and American Wood Reduction Companies. 1919 found him in business for himself, designing power house, producer plant, and other buildings for the Southern Division of Corning Glass at Kingsport, Tenn. The next year he went to work for that company as mechanical superintendent. In 1923, he was transferred to the Corning, N. Y., plant as plant engineer in charge of engineering, construction and maintenance as well as power house operation. In this position, Mr. Vaksdal is responsible for the spending of upwards of a million dollars a year in payrolls, materials consumed, and so on. * * * In his eleven years at Corning, he has vastly improved the operation of the power plant and has built office buildings, a tubing plant, a clay plant, rebuilt a clubhouse, and expanded the company's Rhode Island Division, this construction again running over the million mark. Recently he converted all glass-melting and other furnaces of the company from coal and oil firing to natural-gas firing. All this work has given him a rich background of experience with costs and with that power bugaboo—maintenance.

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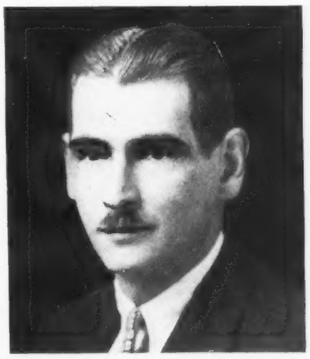
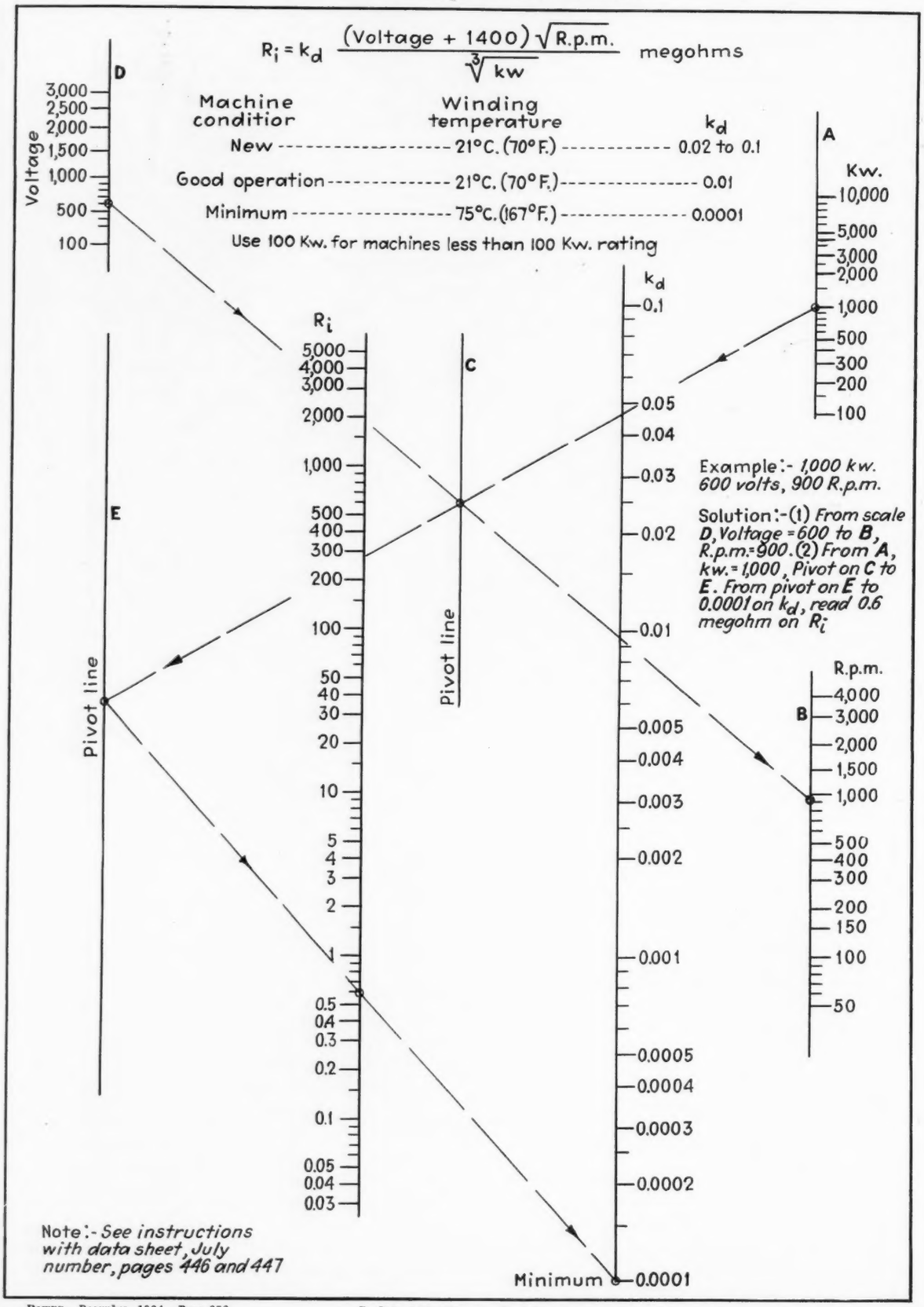


FREDERICK S. KRIGER

"Manage Maintenance"—Page 652

EFFECTIVE side-kick of Alfred Vaksdal, Frederick Kriger also does his bit on the article "Manage Maintenance." He is likewise a member of the New York State Society of Professional Engineers and the American Society of Mechanical Engineers, as well as co-author of several other technical articles. * * * Born Sept. 16, 1899, Frederick Kriger grew up in Corning, went to school and the Free Academy there, on to two years of chemical engineering courses at Rensselaer Polytechnic Institute, then into the Student Army Training Corps. Finally he graduated with the degree of B.C.E. from Ohio State University in 1923. * * * His practical training included drill press and machine operator for Ingersoll-Rand Company, rodman and chainman with the City of Corning Dept. of Public Works, finally as laboratory assistant on fuel and raw material analysis for Corning Glass Works. * * * Robert O. Hayt, consulting engineer of Corning, used Mr. Kriger for two years on topographic and hydraulic surveying and drafting, acting in the field as chief of party, designing and operating a stone-crushing plant, a municipal water works, sewage disposal plants. 1925 found him back again with Corning Glass, first as structural designer, estimating alterations and new construction, plant and departmental layouts, safety and fire protection, studying economics of changes. In 1928 Mr. Vaksdal made him assistant plant engineer, working on maintenance, construction, power services and plant services from estimates and design to completion. His superior considers him a very able engineer, his greatest contribution being his work with maintenance.

ARMATURE INSULATION RESISTANCE
D. C. Motors and Generators

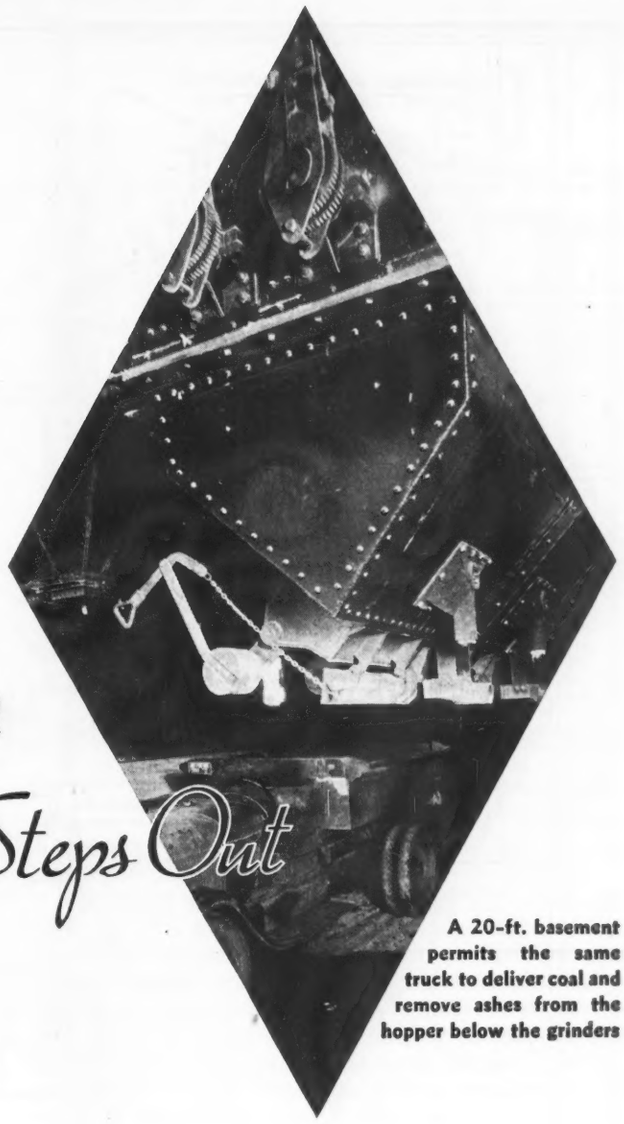


By Robert W. Wieseman, Designing Engineer, General Electric Co. (A.I.E.E. Journal, June, 1934)

© POWER

Since 1928, this paper mill has been modernizing, with a consistent eye to the future while meeting immediate power plant needs. The result is a power plant that is up to date, flexible, economical and that can be increased in capacity easily as need requires

FORT HOWARD PAPER *Steps Out*



A 20-ft. basement permits the same truck to deliver coal and remove ashes from the hopper below the grinders

PROGRESSIVE modernization and expansion, with the needs of the future constantly in view—that is the story of the success of the power-plant installation of Fort Howard Paper Co., Green Bay, Wis. Originally this plant, which makes tissue paper, had two paper machines. Power was purchased, steam generated for paper mill drives and for drying.

In 1928, the original four h.r.t. boilers were supplemented with a 5,000-sq.ft., 300-lb., underfeed-stoker fired, bent-tube boiler in a new boiler house. The building, constructed to house two boilers, included a 9x190-ft. concrete stack.

In 1929, a 1,500-kw. extraction turbine was put into a turbine room built onto the boiler house. At that time, building and piping system were arranged for two main turbines, the space for the second unit being utilized temporarily for a 100-kw. non-condensing turbine to furnish current when the mill was not in operation.

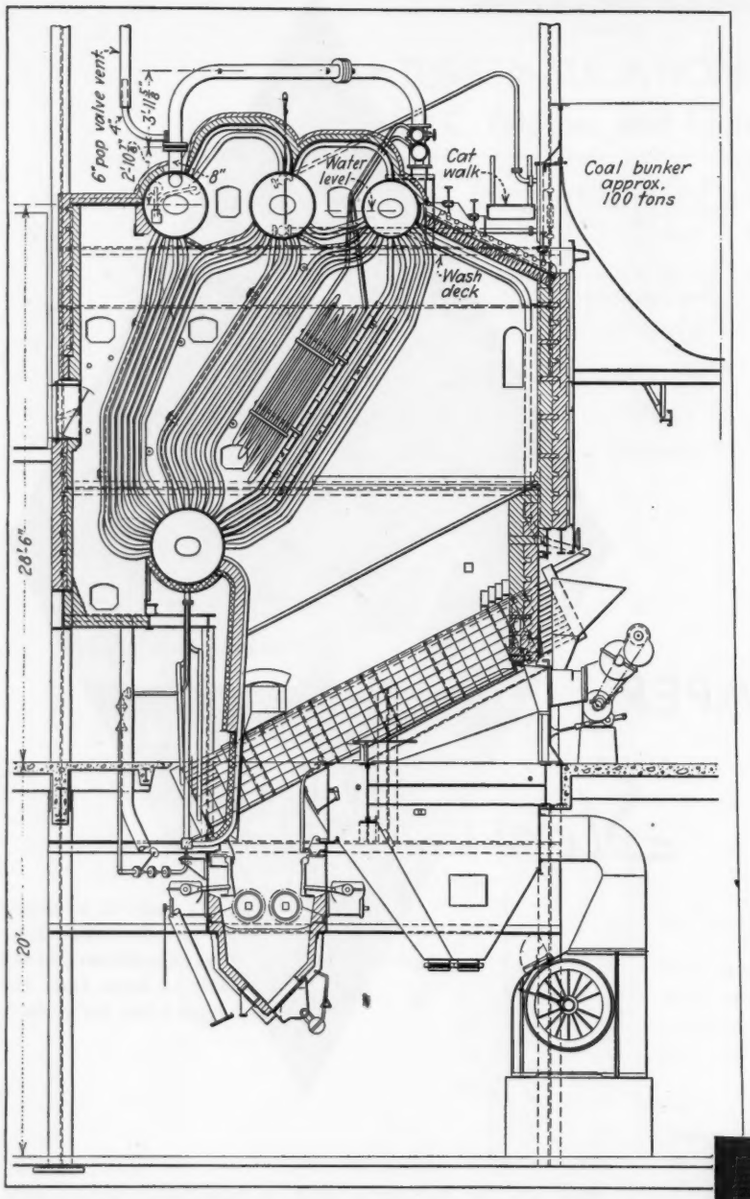
In 1930, a second 7,000-sq.ft., 425-lb. boiler was installed to carry normal full plant load. Both boilers are fired by 6-retort underfeed stokers with power dumps; the second boiler has a water-cooled bridge wall.

When the first turbine was put in, electric load was 1,100 to 1,200 kw., and total steam load was readily handled by No. 2 boiler. But addition of a third paper machine and increased business raised electrical load to 1,600 to 1,700 kw., with steam demand beyond the economical operating point of the main unit.

New Boiler

In the fall of 1933, a third boiler was added, of the same section as No. 2, but with furnace width increased to 16½ ft. and heating surface to 10,000 sq.ft. The firing floor of the extension built to house this boiler was raised 5 ft. above that of the original plant, thus giving a basement 20 ft. high, floor to floor. This permits a clinker grinder and hopper emptying directly into trucks. The new coal bunker, an extension of the old one, is served by the same elevator and distributor. Stack draft is ample for present loads but space permits future installation of an economizer or air preheater with induced-draft fan.

Boiler No. 3, put on the line in May, with its stoker and superheater, is designed for an ultimate output of 100,000 lb. of steam per hr. at 420 lb. pressure and 600 deg. F. Superheater elements can be added to bring temperature to 700 deg. This boiler has block-faced side water walls, extending 3½ ft. above the grate. The bridge wall screen extends to the bottom of the ashpit. A single-pass baffle has proved most satisfactory in service, giving greatly reduced friction through the tubes, while maintaining low flue-gas temperatures. Load on the boiler has so far not been over 150 to 175 per cent of rating, and under these conditions the unit starts with efficiencies of better than 80 per cent. Results have been so satisfactory that No. 2 boiler has been remodeled to



No. 3 boiler is a 10,000-sq.ft. unit with partial water walls

The floor of the new section is 5 ft. above that of the old

correspond as nearly as possible with No. 3 in baffling.

The stoker on the new unit is driven by a constant-speed motor through a hydraulic drive. The clinker rolls are also hydraulically driven. Coal is delivered to the boiler by a weigh larry, and steam is measured by a flow meter checked by a Venturi-type meter in the feedline.

Forced-Draft Fan

A forced-draft fan with variable-speed motor supplies boilers No. 1 and No. 2, with automatic control of windbox dampers. The fan for boiler No. 3 is driven by a constant-speed motor with automatic control on fan inlet dampers only. Automatic controls operate all outlet dampers and the hydraulic speed variator of the stoker drive on boiler No. 3.

Two centrifugal main feed pumps (one turbine driven, the other motor driven) are supplemented by a smaller duplex for Sunday use. Feedwater is chemically conditioned, so successfully that tubes have not been turbined to date.

Coal is received by barge and moved by truck to the foot of the elevator delivering it to the overhead bunkers. The same truck removes ashes from the hoppers under the clinker grinders. West Virginia and Pennsylvania coals are burned.

Recent improvements, made along the lines laid out by the consulting engineers at the time of the original turbine installation, have been made without interfering with plant operation. Boiler-plant arrangement has been changed only slightly, the building and piping simply being extended to provide for a third boiler. All main steam piping now has steel fittings without gaskets, joints being sealed by welding. Feed piping, where not welded, has forged ends with male and female flanges. Blow-off piping is generally welded from the flanged valves at the boilers. All the more recent piping is seamless steel tube.

New Turbine

The 400-lb., 3,000-kw. condensing turbine is designed for automatic extraction at pressures of 100 lb. and 35-40 lb., and to bleed at 5 lb. 100 lb. is not being used at present; 35-40-lb. bled steam supplies the paper machine; 5-lb. steam will take care of building heating, except in extreme weather. Water rate of the unit at full load, without extraction, is 12 lb. per kw.-hr., while first-stage construction permits maximum throttle flow of 85,000 lb. per hr.

Both turbines have divided-waterbox surface condensers, the smaller with 1,500 sq.ft. of surface, the larger 3,000. Each has its own circulating pump and the design provides for a second 2,400-g.p.m. circulating pump for the larger unit should electrical loads increase out of proportion to the quantity of steam extracted. Both condensers have duplicate discharge piping, so that in summer all condenser water goes to waste, in winter to the mill.

Current from the new generator is taken by bus to the circuit breaker on the basement board. This board carries only circuit breakers and their disconnects, the control board in the turbine room above carrying the instruments and operating switches for the main board. Space is available on both boards for whatever additional equipment may be required. The bus work has five 4x¼-in. bars on each polarity, each bar direct to the 6-pole (each 2,500-amp. capacity) air circuit breaker, solenoid operated and controlled from the pilot switch above.

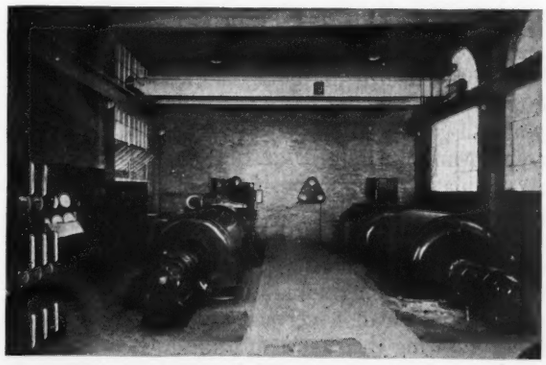
Power for paper machines No. 1 and No. 2 is generated in the turbine room by two 200-kw. variable-voltage d.c. generators driven by a 600-hp. synchronous motor. This synchronous motor serves to a considerable extent in power factor correction, maintaining p.f. at the switchboard over 90 per cent ordinarily. This permits of generator operation nearly up to the ampere rating.

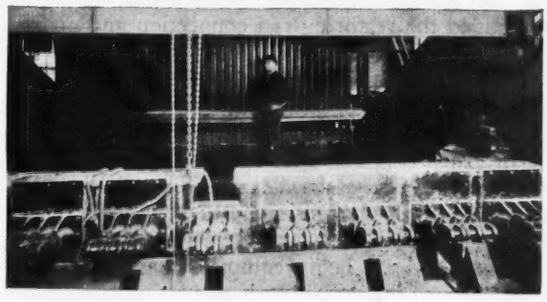
Unanticipatable Demand

In a plant of this kind the output of the power house is mainly current to operate production machinery and steam to dry paper. The ratio of heat to power load is not determinate. The quantity of steam required for the dryers of a paper machine is probably in fairly constant proportion to the power required as long as the grade of paper is not changed. But the power used in preparing the raw material, and that required for converting the paper after it is made cannot be predicted in advance. In this plant, more power is now required than could be furnished by non-condensing turbines exhausting to process. Ample water is available, so condensing extraction turbines are used.

Extraction pressure for the main process varies with the quality of paper. For the output of Fort Howard, the pressure required is 35 to 40 lb. at the turbine outlet. The throttle pressure of 400 lb. gives maximum power output with the selected extraction system and reasonable investment in boiler and turbine. Total temperature of the superheated steam is governed largely by extraction pressure in its relation to throttle pressure. With an inlet temperature of 600 deg., extraction steam is slightly superheated, but the superheat is fairly well dissipated by the time the steam reaches the dryers.

Turbine room, and (below) boiler detail





PRINCIPAL POWER EQUIPMENT
Fort Howard Paper Company

Turbines—One 3,000-kw. 440-volt, double extraction condensing and one 1500-kw. single automatic extraction condensing	General Electric Co.
Condensers and Auxiliaries	Foster Wheeler Co.
Boiler—Stirling type, 10,000 sq.ft., 425 lb. design pressure	Babcock & Wilcox Co.
Water Walls	Babcock & Wilcox Co.
Stoker—9-retort, 29-tuyere, 234-sq.ft. projecting area with 18 in. crusher rolls and Hele-Shaw drive for stoker and rolls	American Engineering Co.
Superheater	Superheater Co.
Boiler Setting	National Power Construction Co.
Steam Piping	Wm. A. Pope Co.
Valves and Fittings	Crane Co.
Insulation	Smith-Totman Co.
Bleeder and Atmospheric Relief Valves	Davis Regulator Co.
Pop Valves	Crosby Steam Gauge & Valve Co.
Blow-Off Valves	Yarnall-Waring Co.
Feed Pumps (Centrifugal)	DeLaval Steam Turbine Co.
Feed Pump Drives	General Electric Co.
Ash Hopper	Beaumont Birch Co.
Forced-Draft Fan—36,000 c.f.m. at 6-in. S P	Clarage Fan Co.
Soot Blowers and Water Column, Diamond Power Specialty Corp.	
Feedwater Regulator	Bailey Meter Co.
Boiler Meter	Bailey Meter Co.
Weigh Larry, Coal, and Soot Gates	Link-Belt Co.
Coal-Conveying Equipment	Jeffery Mfg. Co.
Boiler house Extension Roof	M. H. Detrick Co.
Feed-Water Treatment	Hall Laboratories
Building Construction	Selmer Co.
Structural Steel	Wisconsin Bridge & Iron Co.
Duct and Plate Work	Wisconsin Fabricating Co.
Switchboard Construction	Marquette Electric Switchboard Co.
Circuit Breakers	I. T. E. Circuit Breaker Co.

Power House

A few notes on the power house itself may be of interest. The building is brick, with concrete walls and roof. The new boiler room has exterior walls carried entirely on the steel structure. Four interior columns receive the ends of the boiler-drum girders, as well as those which carry the stoker and ashpit construction. The roof girder over the boiler center is strong enough to hoist drums, thus all equipment can be lifted from the basement floor, greatly facilitating erection. Cork insulates the concrete ceiling of the turbine room, which is lined with yellow salt-glazed brick. A 10-ton crane serves the entire room.

All points in the boiler room where operators are expected to go are made accessible by stairways and galleries, and two safe exits are provided for all points in the upper portion of the building. The two-level boiler operating floor is somewhat unusual, but with practically equal boiler capacity at either level, it has not been found inconvenient.

Power plant and buildings were designed by W. L. Fergus & Co., Chicago, consulting engineers.

OLD GOVERNORS Adapted for New REGULATING JOB

By E. B. STROWGER
The Niagara Falls Power Co.

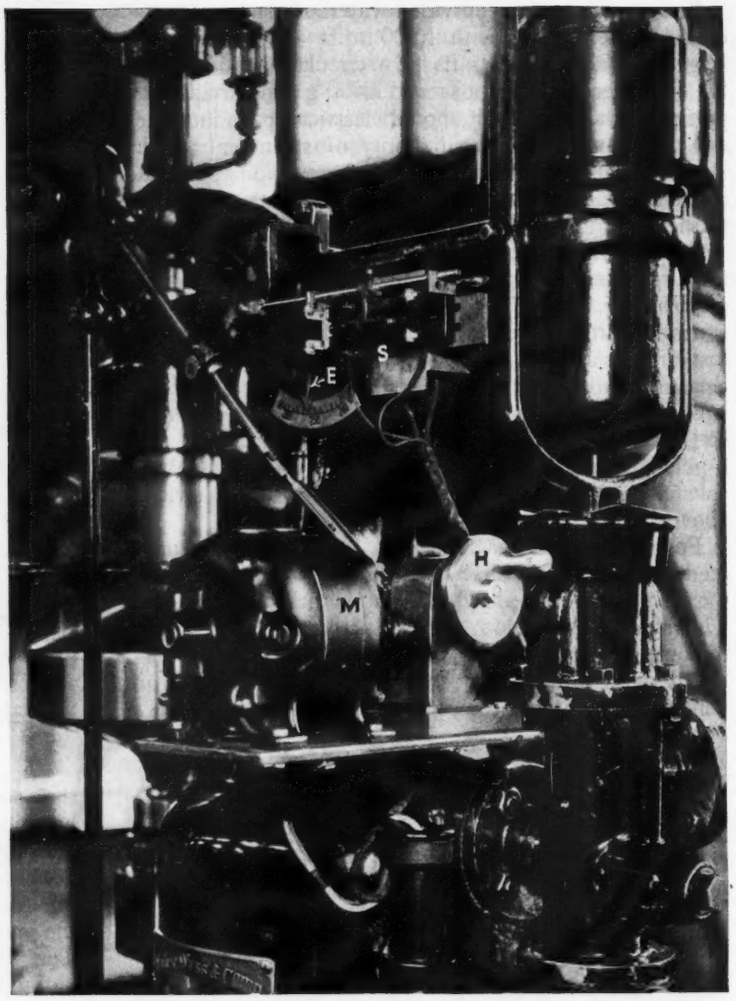


Fig. 1—One of the old governors to which remote-control devices have been added

CHANGES now being made in governing equipment in Adams Station No. 2 of The Niagara Falls Power Company offer an example of old hydraulic-turbine governors adapted to modern power-system needs. These governors are Escher-Wyss design, installed 1902 to 1904, and still operate satisfactorily under conditions for which they were intended. However, the service this station now renders on the Buffalo Niagara and Eastern Power Corporation 25-cycle system requires governing equipment to do more than ordinary speed regulating. Changes are therefore being made to give these governors the desired operating characteristics.

The governors are flyball type with floating lever, the usual primary and secondary compensation including restoring rod and dash pot and a single-acting hydraulic cylinder for turbine-gate control. A rod connects the main hydraulic-cylinder piston to one end of a walking beam on the thrust deck, Fig. 2. From the opposite end of this lever a rod runs to another lever that connects to the gate-operating rods. A 7,000-lb. weight closes the gates by gravity. They are opened by oil pressure admitted to the regulating cylinder in the governor.

Normally, Schoellkopf station regulates frequency for the B.N.& E. 25-cycle system. This plant operates close to full capacity and is limited in incremental generating capacity normally available. When major changes in generating ability or load occur, Adams station is required to help by doing block-load regulation. These units have cylinder gates and give maximum efficiency at full-gate position. They are, therefore, run at either speed-no-load gate or at full gate, economy and voltage regulation being considered. Until quite recently block-load adjustments were made manually, according to instructions from the load dispatcher.

The local load dispatcher would request the floorman, through the station operator, to open up to full gate or close to speed-no-load a certain number of units, an operation requiring the floorman to go to each unit and operate the governor-eccentric hand-wheel. This in effect changed the restoring-rod connection and opened or closed the gates as required. Many load changes are made in this station, consequently the floorman did considerable walking during his 8-hr. shift. To expedite operations and give the switchboard operator quicker control of block-load changes, remote operation of the eccentric hand-wheel has been tried. The trial installation makes the load changes smoothly and quickly and relieves the floorman of a large amount of work. All units in the plant are being equipped now for remote operation.

A split-field, direct-current motor, *M*, Fig. 1, operates the governor eccentric, under control from the switchboard. A clutch allows the floorman to disengage the motor and operate the eccentric by handwheel *H* when desired. On the switchboard control switch *C*, Fig. 3, makes load changes. Regulating switch *S*, operated by an arm from the eccentric indicator, limits gate movement.

For example, consider the unit at normal speed (25-cycles, zero gate). Eccentric pointer *E* is at 247.5 r.p.m., the raise contact on switch *S* is closed and the lower contact is open. The kinematic arrangement is such that the governor-eccentric position is at 24.9 cycles at this speed and gate (25 cycles, zero gate), and the pilot valve slightly on the closing side of neutral. The operator can now cause the unit to take load only by putting switch *C*, Fig. 3, in the raise position.

Consider the unit at normal speed (25 cycles, full-gate), but with the lower contacts on switch *S* closed and raise contacts open. The governor-eccentric position is at 25.1 cycles at this speed with the pilot valve slightly on the opening side of neutral. Now the control device can cause the unit to reject load only when the operator puts control switch *C* in the lower position. The gate-speed diagram, Fig. 4, shows that when the frequency gets outside the range of 25 ± 0.1 cycles, the speed-head governor controls speed in the ordinary way.

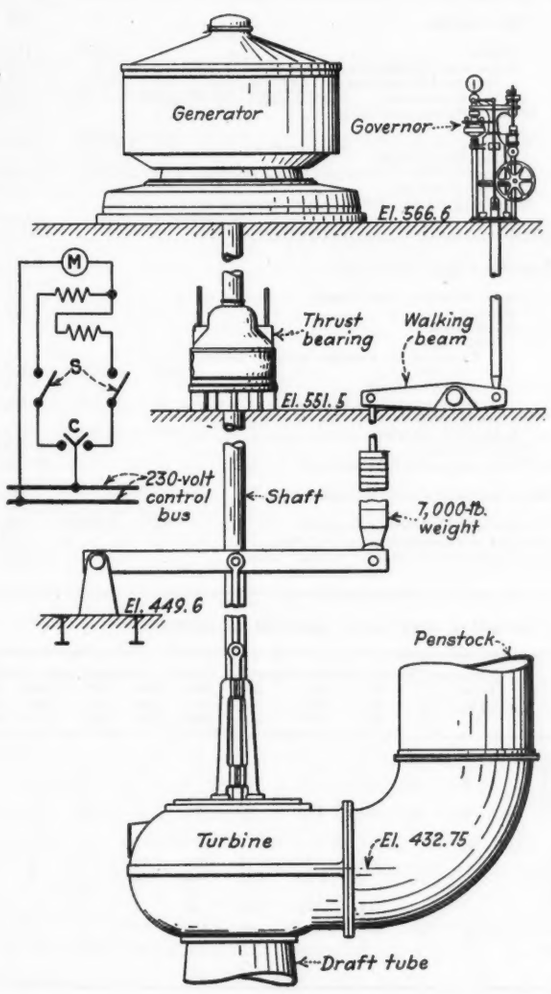
When a major 25-cycle load change occurs, the load dispatcher instructs Adams No. 2 plant switchboard operator as to the capacity change. This operator throws control switches to either lower or raise position and these governors close or open the turbine gates. Suppose, for example, that a heavy increase in load comes on the system. The load dispatcher then instructs Adams switchboard operator to put on, say, units Nos. 15 and 16, which are operating at speed zero gate. Control switches on these units are then thrown to raise position and the governor eccentric assumes a position corresponding to about 25.1 cycles. Since system speed is relatively constant, the pilot valve moves to gate-opening position and causes the machine to take load. The restoring mechanism checks gate motion and they open intermittently, adding load relatively slowly.

This block-load change at Adams station is really a coarse adjustment of system frequency. It is followed by fine adjustments made by governors on Schoellkopf-station units or by operators controlling frequency manually. If a load change occurs opposite to that anticipated by the dispatcher, frequency then departs from normal in the reverse direction. No correction is made immediately, except that by the governor speed heads. The frequency meter, however, shows the operator what has happened and he closes control switches to correct for the load change.

Major load changes may also be handled in the usual way by the governors if the control switches are left in neutral. In this case, when the dispatcher anticipates a load change, he estimates its approximate size and notifies Adams operator to place eccentric pointers approximately at the 25-cycle position. The governors affected would then assume normal control of the units for regulating purposes.

If a unit suddenly lost its load, the governor flyballs would control speed, regardless of control-switch setting, and the turbine gates would close. When synchronizing, the control switch may be used to bring speed to normal value. This saves considerable time in synchronizing at periods when system conditions are critical.

Fig. 2—General arrangement of one of the old hydro-electric units. Fig. 3 (Insert)—Diagram of electrical connections for governor remote-control attachments



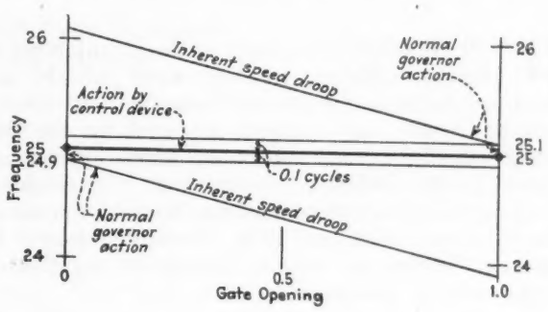


Fig. 4—Speed-gate diagram, showing how governor functions

Largest Steam Central Stations—Hudson Ave., 770,000 kw.; Hell Gate, 605,000 kw.; Trenton Channel, 300,000 kw.; Waterside Nos. 1 & 2, 446,000 kw.; East River, 374,000 kw.; Crawford Ave., 635,000 hp.; Kearny, 431,000 hp.; Long Beach 1, 2 & 3, 556,300 hp.; Fisk St., 345,000 hp.; Philo, 328,000 hp.; Cahokia 313,000 hp., State Line, 278,928 hp.

PRODUCTION OF

PRIME MOVERS IN 1933

A Tabulation by the Census Bureau

Employment increased 40 per cent during 1933. Among stationary units, steam turbines were valued at $2,550,000, diesels at $2,270,000 and steam engines at $217,000

EMPLOYMENT increases in the manufacture of engines, turbines, tractors, water wheels, and windmills in the United States in 1933 from a total of 20,407 wage earners, reported for the first quarter, to 27,001, reported for the fourth quarter, are shown for the industry, according to a preliminary tabulation of data collected in the Biennial Census of Manufactures taken in 1934, recently released by Director William L. Austin, Bureau of the Census, Department of Commerce.

The value of engines, turbines, tractors, etc., made in 1933 by establishments engaged primarily in this line of manufacture amounted to $75,966,225, a decrease of 56 percent as compared with $172,677,421 reported for 1931, the last preceding census year.

The values of the principal items for 1933 are as follows: Steam engines and steam turbines, $5,013,229; diesel and semi-diesel engines, $5,161,489; other internal-combustion engines, $23,160,359; tractors, $18,344,835; water wheels and water turbines, $448,863; windmills and windmill towers, $1,661,134.

Table 1.—Summary for the Industry

	1933	1931
Number of establishments	174	204
Wage earners (average for the year)	22,817	34,130
Wages	$22,645,905	$39,232,394
Cost of materials, fuel, and purchased electric energy	$40,399,308	$82,514,937
Products, total value	$93,889,745	$193,962,805
Engines, turbines, tractors, water wheels, windmills, and parts and attachments	$75,966,225	$172,677,421
Other products, value, and receipts for repairs and experimental work	$17,923,520	$21,285,384
Value added by manufacture	$53,490,437	$111,447,868

This industry, as defined for census purposes, embraces establishments engaged wholly or principally in the manufacture of steam engines and turbines, internal-combustion engines, tractors, water wheels and water turbines, and windmills. The statistics relate to the manufacture of the several classes of prime movers made for sale as such.

The tables are condensed from those issued by the Bureau of Census, chiefly by elimination of footnotes.

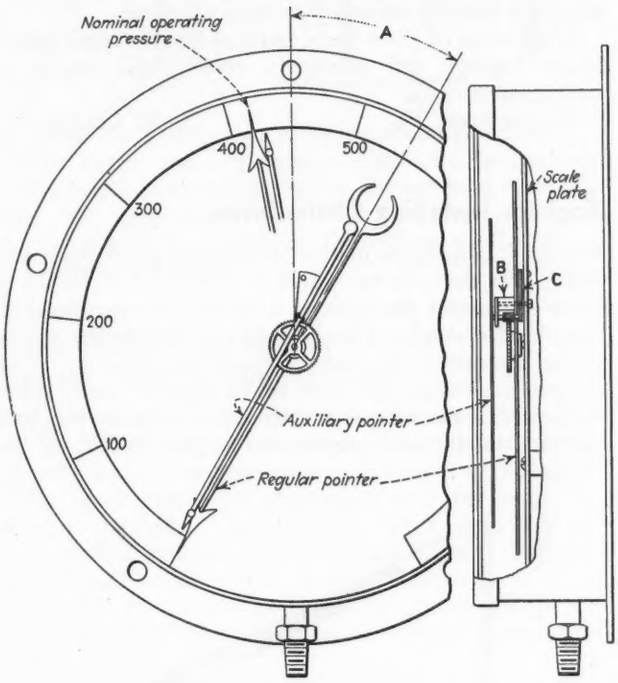
Table 2.—Production, by Class, Type, Number, Rated Horsepower Capacity and Value: 1933

	Number	Rated horsepower capacity	Value
Engines, turbines, tractors, water wheels, windmills, and attachments and parts (including $4,287,069 made as secondary products of other industries)	...	.....	$80,253,294
Steam engines (except traction) and turbines	...	.....	5,013,229
Steam engines	...	.....	378,245
Marine	9	5,775	160,855
Other than marine:			
Reported by number and by horsepower	70	5,771	139,577
Not so reported	...	.....	77,813
Steam turbines, total value	...	.....	3,973,835
Marine	25	176,920	1,423,502
Other than marine:			
Reported by number and by horsepower	635	282,550	2,512,849
Not so reported	...	.....	37,484
Steam engines and turbines not reported in detail	...	.....	661,149
Internal-combustion engines (except tractors)	...	.....	28,321,848
Injection engines, total value	...	.....	5,161,489
Compression-ignition (Diesel):			
Marine	...	.....	1,827,764
Other Diesel:			
Stationary—			
Reported by number and by horsepower	567	66,505	2,227,637
Not so reported	...	.....	41,374
Tractor, aircraft, railway, etc.	61	15,125	286,708
Surface-ignition (semi-Diesel—hot-spot, hot-bulb, etc.), all types	308	16,603	319,953
Injection engines	...	.....	458,053
Carburetor engines (except tractors)	...	.....	23,160,359
Water wheels and water turbines	...	.....	448,863
Number and horsepower reported	92	37,898	397,933
Number and horsepower not reported	...	.....	50,930
Windmills and windmill towers, total value	...	.....	1,661,134

Table 3.—Classified Production (Is less than total, including only units reported in detail)

Class and Type	Total: Number	Total: Rated horsepower capacity	Total: Value	Number, by horsepower capacity, rated or normal, not overload: Less than 5	5 to 9	10 to 19	20 to 49	50 to 99	100 to 199	200 to 399	400 to 999	1000 to 4999	5000 and over
Steam engines (except traction) and turbines:													
Marine, reciprocating	9	5,775	$160,855	...	...	...	...	..	...	1	6	2	..
Other reciprocating	70	5,771	139,577	8	9	10	19	5	9	7	3	..	..
Marine turbines	25	176,920	1,423,502	...	...	...	...	...	...	4	4	1	16
Turbines other than marine	635	282,550	2,512,849	74	38	101	123	85	85	64	23	36	6
Internal-combustion engines (except tractors):													
Compression-ignition (diesel)													
Marine	208	41,095	1,827,764	...	...	4	26	38	68	45	25	2	..
Stationary	567	66,505	2,227,637	...	11	4	82	256	140	56	15	3	..
Other diesel (tractor aircraft, railway diesel-electric)	61	15,125	286,708	...	...	...	...	...	43	7	11	..	..
Surface-ignition (semi-Deisel), all types	308	16,603	319,953	...	...	19	95	154	38	2	..	..	..
Industrial Carburetor Engines	54,040	284,654	4,029,922	48,027	928	649	2,601	1,408	413	11	2	1	..
Water Wheels & Turbines	92	37,898	397,933	6	...	4	18	17	14	9	10	14	..

PRACTICAL AIDS TO OPERATION



Auxiliary Pointer on Pressure Gage Magnifies Changes in Pressure

MAINTAINING good steam pressure with a single pulverized fuel-fired boiler under manual control depends to a large degree on how readily boiler operators can detect a slight change in pressure, and how responsive the mill is to changes in coal feed. To make slight changes in steam pressure more readily apparent to the operators, we fitted the large indicating pressure gage in our plant with an auxiliary pointer and geared it to the regular pointer in a ratio of 10 to 1.

A small gear taken from the register of a standard watt-hour meter was drilled to fit the pointer spindle, then the two were soldered together. The shape and size of the bracket used to support the pinion on the auxiliary pointer was determined by the space between the ends of the regular pointer when moved between zero and 450-lb. pressure, as indicated at *A* in the figure.

After we had removed the gear train from its housing, a small pinion, with its spindle, was put in place at one end and the housing reassembled. A spacer *B* was fitted between the two sideplates of the housing immediately behind the pinion and soldered in place. Then the upper plate was cut away entirely back to the spacer, while the lower plate was made triangular in shape and of sufficient length to give a good supporting surface. This in turn was soldered to a plate *C* of a thickness to raise the pinion to mesh with the gear on the gage spindle. The assembly was fastened to the scale plate of the gage by a screw through the spacer *B* and two screws at the outer end of plate *C*.

With the gear in position, the auxiliary pointer was set so that the two pointers were parallel at 420 lb., normal operating pressure. As the pressure changes the hands move in opposite directions, and as the pressure returns to normal they approach each other. This movement tends to make a change in pressure more readily apparent than if the hands moved in the same direction but at different speeds.

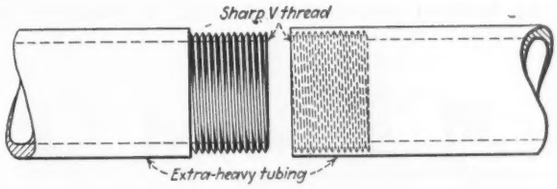
It so happens that the calibration of our gage is such that the hands stand parallel at zero and the auxiliary pointer makes four complete revolutions between zero and 400 lb., standing parallel again with the regular hand at 420 lb. The regular hand on the gage is black, and the auxiliary pointer is red.

Winnipeg, Man. C. L. ALEXANDER

Boiler Tube Replaced in Two Sections

BOILER rooms are sometimes so constructed that no provisions are made for replacing boiler tubes. When a tube becomes defective in a horizontal fire-tube boiler and it cannot be removed without tearing down a brick wall, the tubes may be blanked off or can be replaced by one of two methods. If several tubes are to be replaced, the only choice is usually to tear out the obstructing wall. When one or two tubes are to come out they may be replaced in two sections.

The diagram shows an extra-heavy boiler tube cut in half. One end of one section is turned down to half thickness for about 2 in. This machined portion is threaded with a sharp V thread. One end of the other half is bored out to a size equal to the diameter of the thread root in the first half. The recess in the second



half is bored back 2 in. and threaded with the same pitch thread as the first half.

The rear half of the boiler tube is then pushed through the front tube sheet until about 1 ft. protrudes. The joint is then tightly screwed up and the tube pushed through until it is in position. The ends are then expanded and beaded in the usual manner. The beaded ends of the tube prevent the sections from separating.

Brookline, Mass. H. M. SPRING

A Simple Method of Checking Synchroscope Connections

Two engine-driven alternating-current generators had been operated under load but had not been synchronized. It was my job to check the synchroscope connections and parallel the two generators. Phase rotation of the machines was O.K., as load had been carried by each machine. Where it is necessary to check phase rotation, common procedure is to connect a polyphase motor to

the bus and determine if its rotation is the same when operated from either generator.

To check the synchroscope, we disconnected the generator leads at one machine. With the other generator conected to the bus we closed the idle machine switch to energize its synchroscope potential transformers. The synchroscope indicated synchronism (as it should because both synchronizing potential transformers were energized by the same potential and as it happened both were connected correctly to the synchroscope). The idle generator switch was then opened and the generator leads reconnected and it was now ready to synchronize. The generator was started, and by waiting until the synchroscope pointer had almost stopped and was within a few degrees of reaching the top it was a simple matter for me to put the two machines together.

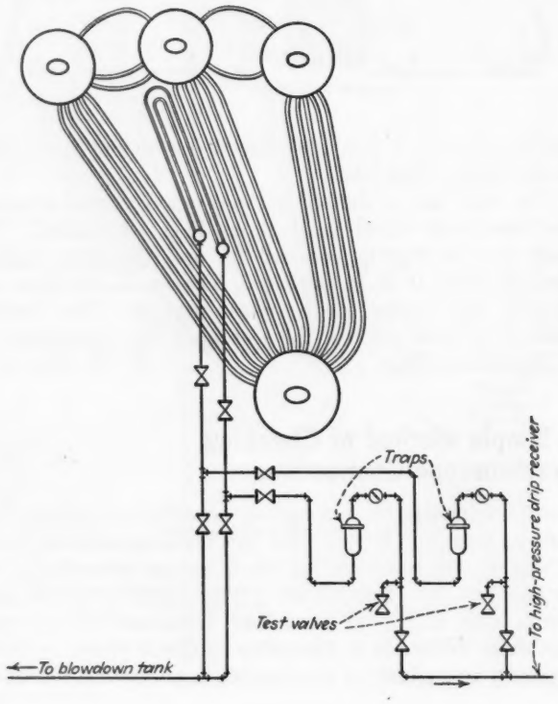
Montague City, Mass. MAX PAFENBACH

Traps Reduce Superheater Maintenance Costs

IN A large 400-lb. pulverized-fuel-fired industrial power plant, superheater headers gave trouble due to leaking. Located within the boiler settings these headers developed leaks at the tube ends and around handhole fitting gaskets. Investigation revealed condensation in the headers during banking periods caused most of the trouble.

Continuity of operation was important; it was necessary to keep one boiler unit banked or in standby service at all times. Availability was maintained by periodically lighting off the unit whenever the pressure fell to a predetermined point. During the intervals of 4 to 5 hr. between these firing periods, steam condensed in the superheater. This relatively cool condensation caused strains at the headers.

Inasmuch as cracking the superheater drain valves during banking periods would result in excessive heat loss and high valve maintenance costs, traps were installed to drain the headers, as in the diagram. The original drain valves were left in place so that the traps might be by-passed during firing periods to insure a flow of steam through the superheater and for draining should it become necessary to repair the trap.



Installation of these traps reduced trouble from superheater leakage and effected a considerable saving in maintenance costs.

Waynesboro, Va. S. H. COLEMAN

Tool for Installing Chain Drives

WHILE it is a simple matter to stretch a small chain and slip it over the sprocket wheel, it is another problem entirely to connect the links of a heavy conveyor chain of considerable weight. I have found the chain puller shown in the diagram to be just the thing for this job. With the two hook ends, the chain comes together easily when the power of the lever is exerted, and the connecting link may be slid into its groove or the pin inserted in the

pintle chain link. This tool will save a lot of bull strength and profanity.

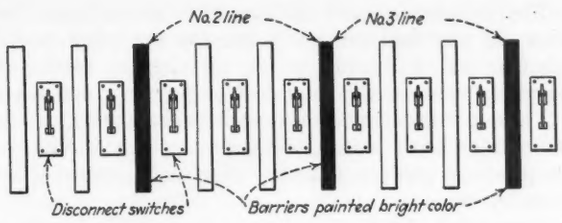
While on the subject of sprocket chain it may be as well to emphasize the point that the wear of sprocket wheel and chain changes their pitch, therefore old chain should not be run on new sprocket wheels, and conversely new chain will not operate satisfactorily on worn sprockets. It is a common error to purchase half the amount of chain required and then join one old link with one new, for in this way you spoil the new links in a short operating period.

Vancouver, B. C. S. H. COOKE

Safety Marking for Disconnect Switches

IN A fairly crowded switch room, it many times happens that disconnect switches are mounted in a continuous row, each disconnect being separated from the adjacent one by only a flash barrier. The mere fact that all of these switches are identical and are uniformly spaced calls for considerable care in their operation, especially where the disconnect is located a short distance from the circuit breaker.

An operator may be a little careless or be rushed when performing a switching operation. As a result, he accidentally opens a disconnect on one phase of an adjacent oil circuit breaker, mistaking it for a switch in the line on which he has opened the oil switch. Naturally such



an operation is dangerous to operator and equipment.

This danger can be practically eliminated by painting, with a bright or contrasting paint, the partition that separates the complete circuits. The accompanying figure shows such an installation on three-phase equipment.

Beaumont, Texas. R. F. SORRELLS

Photo-Electric Cell Insures Ignition Flame in Furnace

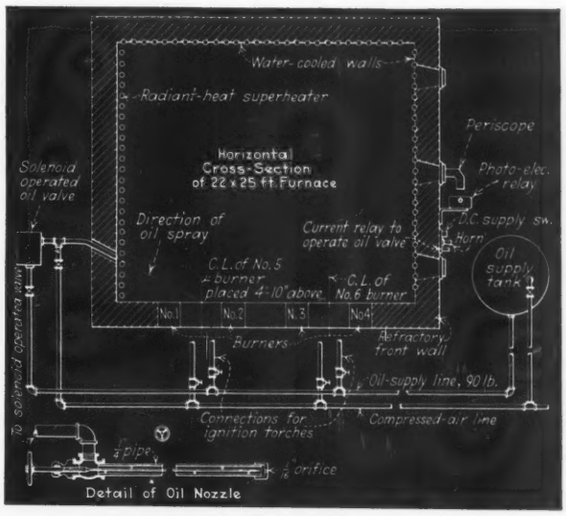
WE USE a photo-electric cell on the furnace of a 16,500-sq. ft. boiler to insure an ignition flame, should the fire go out. Its use was prompted by a number of bad puffs. These were caused by momentary coal feed stops on some of the mills. Owing to the long freight haul, the surface moisture in the slack bituminous coal which we use varies widely with weather conditions. This in turn tends to prevent uniform feeding of coal to the mills, especially when the feed is reduced during light loads.

As shown on the right in the figure, a periscope or angle mirror is used to direct the light rays from the furnace at a right angle onto the photo-electric cell. The d.-c. supply switch, a horn and magnetic contactor, the latter for the solenoid on the oil valve, are mounted on a panel on the boiler casing adjacent to the relay. For the oil-nozzle opening a ¾-in. pipe was placed at the proper height and angle in an inspection port in the furnace wall and the opening bricked up. The oil burner, consisting of a ¼-in. pipe with an orifice on the inner end, is pushed through the ¾-in. pipe even with the inner face of the furnace wall as in the figure.

To prevent failure of the device due to plugging of the nozzle with dirt or carbonized oil, a small rod with suitable guides and a long needle point is inserted in the ¼-in. nozzle connection. This small rod is attached to the stem of a ¼-in. angle valve. Once every 24 hours the needle point is pushed through the small orifice and withdrawn by turning the valve stem.

The oil connection to the valve is taken from the header supplying the hand torches used in the furnace when lighting up from a cold start. A compressed air connection is also made to the orifice pipes to permit blowing the pipe clear of oil after each operation.

Cleveland, O. R. M. BOWSER



CURRENT COMMENT

High- Vs. Low-Speed Diesels— Some Operating Figures

MR. SCHAEFER'S proposal of a battery of 64 high-speed diesels of 100 hp. each (May, 1934), as against one 6,400-hp. unit has opened a chance for engineers to present their operating costs on diesels.

In the August number, I paid particular attention to J. H. Bender's article. Mr. Bender asked for records on such operation, and as I have both types of engines working under the same conditions, I would like to throw some fuel on the fire. I am operating three high-speed diesels of 120 hp. each and one slow-speed stationary engine.

First, let me give a general plan of our set-up. The slow-speed stationary engine is set up as a unit in a power house—dustproof and weatherproof—belted to a 250-kva. generator. The small units are individually housed in different locations, each in a house, but not as thoroughly protected as the larger engine. The smaller units are belted to their loads, which are full-load, full-speed, at all times.

The cost of the three high-speed units complete, fuel and air tanks and radiators is $2,500 cheaper than the large unit complete. All are of the same make and are using the same fuel—32-36 deg. Bé—and the same lubricating oils. The following data taken from my log may be used as a fair comparison:

	Slow-speed	High-speed
Fuel oil, lb. per b.hp.-hr.	0.38	0.36
Lube oil, gal. per hp.-hr.	0.00085	0.002
Top overhaul, after—hr.	2,300	1,000
Ring renewals, after—hr.	4,500	2,500*
Complete overhaul, after—hr.	8,500	4,500

*also wristpin bushing renewal.

I find that the amount of wear on connecting-rod bearings is nearly eight times greater on the high-speed engines than on the slow-speed (330-r.p.m.) type.

Operating expense is divided into two parts, one opera-

tor per shift for the large engine, and one operator per shift for the three high-speed units. This is necessary, as the small units have their individual fuel tanks, radiator to be filled, while greasing, oiling and wiping requires one man's time. I would appreciate hearing from other engineers on their operating costs to make a fair comparison.

Mariposa Co., Calif. WILLIAM TAYLOR

Gas Producers vs. Diesels

REFERRING to Mr. Lustig's interesting article "Dead or Alive? The Power Gas Producer is Alive" in the August number of *Power:*

The gas producer was well known here fully forty years ago, but in spite of substantial improvements in details and in control and gas washing equipment and the efforts of gas engine and tank manufacturers, it has not made any substantial commercial progress in this country.

For special reasons, not applicable here, its use has increased abroad, especially in Asia and North Africa.

I have followed some of these foreign developments, and have looked for the cause of lack of interest in the United States. It seems to be an economic problem. Technically the producer plant can be made to operate as successfully as the oil engine or steam plant. Practically, the increased first cost of land, building and machinery often combined with greater operating labor cost, more than offset the fuel saving. Variations in all the costs, both of installation and of operation make comparisons impossible except for clearly defined conditions. However, the following table may serve as a guide to the general situation in the United States.

A—Diesel-Electric Generating Plant, including land, building, oil engines, electric generators, waste heat boilers, all with normal auxiliaries. Rated capacity between 300 and 1,000 kw.

First Cost—between $150 and $175 per kw.
Fixed Charges—15 per cent per year.

OPERATIONS—Per Kilowatt Instead of Installed Capacity

	Average, ¼ load 8 hr. per day 2,400 hr. per year	Average, ⅓ load 24 hr. per day 8,760 hr. per year.
Output per year	1,800 Kw.-hr. per Kw.	4,380 Kw.-hr.per Kw.
Fixed Charges, per kw.-hr	12 to 15 mills	5 to 6 mills
Production:		
Fuel	4 to 5 mills	4 to 5 mills
Labor	3 to 6 mills	3 to 6 mills
Other Costs	3 to 9 mills	3 to 9 mills
Total Cost, using Diesel Engines	22 to 35 mills	15 to 26 mills

B—Gas-Engine Producer Plant, complete as above.

First Cost increased 30 per cent to 40 per cent, to between $195 and $245 per Kw
Fixed Charges—15 per cent per year.

OPERATIONS—Per Kilowatt Instead of Installed Capacity

	Average, ¼ load 8 hr. per day 2,400 hr. per year	Average, ⅓ load 24 hr. per day 8,760 hr. per year
Output per year	1,800 Kw.-hr. per Kw.	4,380 hr. per year
Fixed Charges, per kw.-hr	16 to 20 mills	6 to 8 mills
Production:		
*Fuel	2 to 4 mills	2 to 4 mills
‡Labor	4 to 7 mills	4 to 7 mills
†Other Costs	4 to 11 mills	4 to 11 mills
Total Cost, Using Gas Producers	26 to 42 mills	16 to 30 mills
Increase Over Diesels	4 to 7 mills	1 to 4 mills

*Ing. Lustig gives the fuel cost, Table I, for producer gas at 2.17 mills per kw.-hr., evidently based on full-load operation. He gives diesel fuel as 3.45 mills, compared with 4 to 5 mills used above.

‡Under American conditions the handling of coal and ashes, cleaning of producers, scrubbers, etc., would certainly involve higher attendance costs.

†The cost of supplies, repairs and replacements would also increase.

The waste heat recovered, in equally well designed plants, would not be materially different with oil engines or producers.

The increase in fixed charges, labor and upkeep would wipe out any fuel savings in the average plant, and the substitution of producers for oil engines would substantially increase the total cost of power in most cases.

There are local conditions, such as cheap coal, available labor, very high load factors, etc., which would make the producer gas plant worthy of consideration for some installations.

New York, N. Y. OLIVER F. ALLEN
Consulting Engineer

Diesel Noise and Vibration

IN THE August number of *Power,* I find that two replies recommend the use of lead plates for elimination of diesel vibration. I have not had experience with lead plates under diesels, but have had experience with them under other machinery, and their use has not been as satisfactory as has cork isolation board. Besides, lead plates are much more expensive than cork.

Atlantic Highlands, N. J. M. M. GOOCH

Uses a Star-Delta Starter on Standard Motor

IN THE October number, R. Smith mentioned a switching arrangement for temporarily operating star-delta motors. It is sometimes thought that these motors must be started on a star connection and run on a delta. This is unnecessary if an ordinary compensator is available. Usually when a motor breaks down, its compensator or across-the-line starter is unimpaired. When necessary to substitute a star-delta motor for a standard type, it may be connected delta and started with the former motor-starting equipment.

Recently it became necessary to remove a defective 52-hp. star-delta connected motor, and to substitute a 50-hp. motor that had three leads only. As the breakdown occurred at night, it was impossible to procure a 50-hp. compensator, and the star-delta starter on the 52-hp. motor was apparently useless. It was found, however, that the 50-hp. motor had a delta connection. The ends of each phase winding were disconnected and brought outside the motor. The machine was then treated as a star-delta machine and the six leads hooked up to the starter in the usual manner.

Toronto, Ont. L. A. HUNT

Stack Lasted 65 Years

AN EDITORIAL in September *Power* commented on wrought iron vs. steel stacks. Here is an actual experience:

In 1902 I dismantled the plant of the Cable Mine of the Coal Valley Mining Co. near Rock Island, Ill., but found none of the equipment suitable for the new mine. The boilers were of the two-flue, riveted type and the engines of very ancient design, the original plant having been erected in 1859. The only part that attracted my attention was a 48-in. stack, only 50 ft. high.

I asked a firm in Davenport, Iowa, to give me a bid on another 50-ft. extension to be used as the base of

the longer stack. When the bid came in, a footnote indicated that the old stack had been built by the father of the then president. I suggested that the old stack be used at the foot and the new section on the top, believing the old material would outlast the new. This was done and during my connection for 15 years with the company, the stack continued until the mine was worked out in 1918.

The wrought iron stack had a life of 65 years and, as I now recall, was not painted until the new extension was made.

Charleston, W. Va. CARL SCHOLZ

Kilowatts from Hot Water

I HAVE just finished reading H. V. Schoepflin's article, "By-Product Kilowatts from Hot Water," (October *Power*) and was struck by the statement at the end of the article that "the only heat wasted is the inconsequential amount carried off in the gland water."

This statement is correct for the heat used for generating the power, but I desire to call to your attention the possibilities of heat recovery from the waste hot process water from the dye vats. This is a field which has been given very little attention up to the present time, except in laundries.

For example: In the dye houses I have surveyed thousands of gallons of waste hot water are dumped daily to the sewer at an average temperature of 150 deg. F.

To make a long story short, the point I wish to bring out is that any power hook-up for an industry which uses large amounts of hot process water should give a careful study to the possibilities of reclaiming the heat from the waste hot water.

Medford, Mass. ABBOTT ALLEN

Distant Gages for Liquid Level

IN THE August *Power*, Mr. Emison's article, "Builds Gage to Show Level in Oil Tank," was interesting to me, but two errors should be noted. These do not materially change the design worked out but would be serious in some cases. The following formulas are derived, using the symbols in Mr. Emison's article, and several others are added to cover omitted hydraulic heads. For convenience all are repeated here, the dimensions being given in inches:

A = static head of gage indicating fluid on the mercury at zero gage.
B = difference of mercury level at zero and maximum gage.
D_1 = bore of mercury wells
D_2 = bore of gage glass.
d = density of fluid in U tube (mercury).
d_1 = density of fluid in the tank.
d_2 = density of fluid in the gage.
T = desired travel of indicating fluid in gage.
H = desired variation in the level of the liquid in the tank.
M = difference in level of mercury legs at zero gage.
S = height of fluid in tank at zero reading, measured from mercury in lower cylinder.

$$\frac{B}{T} = \left(\frac{D_2}{D_1}\right)^2 \quad \text{.....(I)}$$

$$B(2d - d_1 - d_2) = Hd_1 - Td_2 \quad \text{.....(II)}$$

$$Md = Sd_1 - Ad_2 \quad \text{.....(III)}$$

(I) and (II) gives

$$D_1 = D_2\sqrt{\frac{T(2d - d_1 - d_2)}{Hd_1 - Td_2}} \quad \text{.....(1)}$$

$$= D_2\sqrt{\frac{T(27.2 - d_1) - Td_2}{Hd_1 - Td_2}}$$

(III) gives $$M = \frac{Sd_1 - Ad_2}{d} \quad \text{.....(2)}$$

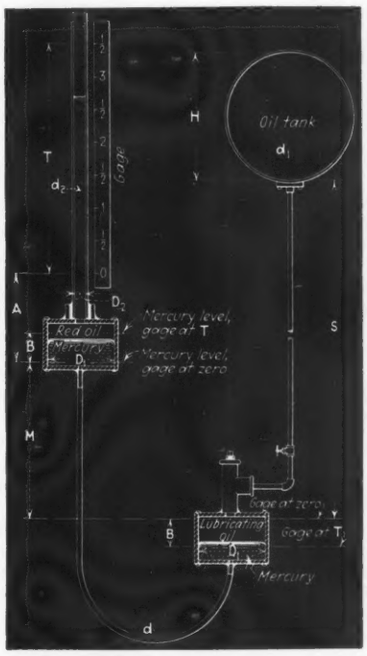
and $$B = T\left(\frac{D_2}{D_1}\right)^2 = \frac{Hd_1 - Td_2}{2d - d_1 - d_2} \quad \text{.....(3)}$$

$$\frac{H}{T} = \left(\frac{D_2}{D_1}\right)^2 \frac{2d - d_1 - d_2}{d_1} + \frac{d_2}{d_1} \quad \text{.....(4)}$$

Comparing these formulas with those in August *Power*, it is apparent in No. 1 that in the numerator Hd_1 should have read Td_2, and in No. 2 a correction factor $Ad_2 \div d$ was omitted. In No. 2 the omission is not serious when d is large as compared with d_2 which is true with mercury and oil, but in No. 1 the error is too important to be overlooked. This is especially true when the ratio of H to T is large. For example:

Let $T = 12$ in.; $H = 120$ in.; $D_2 = 0.425$ in.; $d = 13.6$ (merc.); $d_1 = 0.905$; $d_2 = 0.845$; $S = 312$ in.

Only H and T have been changed in the example given in Mr. Emison's article, yet D_1 is now equal to 0.75 in. and M is 20.14 in., though when computed by the formulas given in August *Power* they will be 0.615 and 20.8 in. respectively. Now if the wells were made 0.615 in. in diameter for this gage the value of T would prove to be 20.5 in. instead of 12 in., and this would be disappointing if a 15-in. gage glass had been used.



Formula No. 3 does not correspond to the one given in the article for depth of wells, but the depth of the wells will depend on this value of B and the total volume of mercury. In any case it would be wise to make each well deep enough to hold all the mercury and still have sufficient space above the mercury to prevent it from being forced through the gage in case of accident. For different uses of gages it would be difficult to express this value in a general formula, therefore it seems best to consider each case separately. This is easily done as the design proceeds.

This gage can be equally as well designed to be used on a tank below the gage level, and the "U" tube can be located at any point at any distance from either gage or tank. However, it should be located below the zero level in the tank to prevent air pockets in the pipe line.

University, Va. T. F. NORRIS

READERS' PROBLEMS

QUESTIONS for Our Readers

BONUS SYSTEMS

Question 1

WE WOULD *appreciate any information that you can give us on where to secure reprints or copies of articles describing bonus or wage incentive systems for firemen and engineers, where the men receive a bonus based on the efficiency at which they operate. We are particularly interested in a system for firemen operating 5,000-sq.ft. boilers in a small industrial plant having both heating and process steam loads.*

—J. W. T.

[Similar requests come in from time to time, yet very little has been published recently in the power field relating to bonus and wage incentive systems. Many readers must have had experience with such systems. They are urged to tell other power men what they have found out.

What is desired is not so much abstract ideas on the subject as first-hand experience, indicating what things work, what things don't and why.—EDITOR.]

STICKING COAL

Question 2

WE HAVE *experienced considerable difficulty at times with coal sticking up in bins, bunkers and chutes. It has happened with both solid and pulverized coal. Sometimes the cause is fairly obvious—a sharp angle in a chute, a projection or corner into which the coal can pack to start the sticking. Sometimes it simply packs into an arch which stays up when the loose coal beneath flows out. Our methods of handling the trouble have been crude—hammering, pounding and jabbing to restart flow. I am sure that other practical men have had the same trouble, and will wager that some have found more lasting answers. I'd like to know what they are.*—J. N. D.

Suitable answers to these questions from readers will be paid for if space is available for their publication.

WHAT ARE STEAM RATES?

ANSWERS to October Question 1

THE QUESTION

AT PRESENT *we buy all power, but we are considering installing a generating unit to produce part of our power load from process steam. A steam pressure of 125 lb. can be carried on our present boilers. The management is unwilling to buy new boilers for higher pressure at the present time. No superheaters are installed, but they can be if they would pay for themselves in three or four years. Five pounds pressure is ample for process and heating. At no time ordinarily will the process steam produce our full power load—the balance will be purchased as at present.*

We have prepared approximate load curves for steam and power demands and would like some data on the steam consumption of engine and turbine sets of about 200 kw. capacity, both with and without superheat (say 100 deg.), at full load and half load. About what would be the steam rate per kw.-hr. of the following units:

Steam turbine—average
Steam turbine—high efficiency unit
Good Corliss engine
Good uniflow engine.

Can your readers give us this information, based on their actual operating experience over a period of years, with some or all of these machines? Which types fall off fastest in efficiency with use, and about how much? What about their relative costs installed? Any other practical advantages or disadvantages which should be considered in selecting a generating unit?

—W. W. D.

Use a Turbine

THE steam consumption rates, in lb. per kw.-hr., of the generating units under the operating conditions required by W.W.D. will probably fall within the limits shown below:

	With Superheater	Without Superheater
Turbine	25-32	29-34
Corliss	25-29	27-33
Uniflow	22-26	25 29

Of course it must be realized that it is difficult to predict steam rates under varying load conditions, but the data given before indicates representative results. Although a turbine drive will be slightly less efficient, its installation will probably be more economical in the end due to small amount of attention, reliability, and low maintenance cost. The turbine will also show the least falling off in efficiency.

It is doubtful if a superheater will pay for itself in three or four years; however one should be installed since it will not only increase the efficiency but will also give dryer steam for process work.

Westfield, N. J. GORDON R. HAHN.

Use Uniflow and High Pressure Or Condensing Turbine

THE simplest way to answer W.W.D.'s question would be to say that a 200-kw. unit would cost about $10,000—if turbine driven, a little less, and if engine driven, a little more, whether a Corliss or uniflow. The uniflow would cost more per pound, but due to its higher speed and smaller size, would cost about the same per kilowatt.

With clean dry steam, the turbine would maintain top efficiency with little maintenance, as would the uniflow. The Corliss, due to its valve and valve-gear design, would require more maintenance and would not maintain its efficiency as well as the others.

The turbine would have a Rankine cycle ratio of about 52 per cent, the Corliss 58.5 per cent, and the uniflow 59.5 per cent, referred to kw. If the throttle steam has a pressure of 135 lb. abs. and a superheat of 100 deg., and the exhaust press is 20 lb. abs., the Mollier diagram shows 1,249 — 1,096 = 153 B.t.u. available. The water rates would therefore be:

$$\frac{3411.5}{0.52 \times 153} = 42.8 \text{ lb. per kw. for turbine,}$$

and similarly 38.1 lb. per kw. for Corliss and 37.5 lb. per kw. for uniflow.

We will assume that the plant runs 120 hr. per week for 50 weeks, making 6,000 hr. per year, the load is 200 kw., and the coal cost is $0.25 per 1,000 lb. of steam.

The uniflow would use

$200 \times 37.5 = 7{,}500$ lb. steam per hr.

The Corliss would use 7,620 lb. per hr.

The turbine would use 8,560 lb. per hr.

In a year's time, the Corliss would use $6{,}000 \times 120 = 720{,}000$ lb. steam, costing $720 \times \$0.25 = \$180$ more than the uniflow per year.

The turbine would use $6{,}000 \times 1{,}060 = 6{,}360{,}000$ lb. steam, costing $6{,}360 \times \$0.25 = \$1{,}590$ more than the uniflow per year.

Evidently a turbine is out of the question for this pressure.

Now as to the superheaters. Will they pay? Although we haven't the number or size of boilers, $3,000 will probably be a good guess as to their cost. If the steam is not superheated, the heat available is 1,192 — 1,050 = 142 B.t.u. This indicates water rates as follows:

$$\frac{3411.5}{0.52 \times 142} = 46.1 \text{ lb. per kw. for turbine}$$

And similarly 41 lb. per kw. for Corliss and 40.4 lb. per kw. for uniflow.

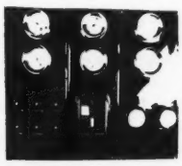
With superheated steam, the uniflow exhausts 7,500 lb. steam per hr. containing 1,096 B.t.u. Assuming that process uses only the latent heat, changing the steam to water at 228 deg. (the temperature corresponding to 5 lb. gage pressure, it therefore uses 1,096 — (228 — 32) = 900 B.t.u. per lb. This amounts to $7{,}500 \times 900 = 6{,}750{,}000$ B.t.u. per hr.

If the steam is not superheated, the exhaust contains only 1,050 B.t.u., and will give to process but 854 B.t.u. This would require $\frac{6{,}750{,}000}{854} = 7{,}900$ lb. steam per hr.

This would be 400 lb. more than if superheated and would generate $\frac{7{,}900}{40.4} = 195$ kw., or 5 kw. less. $6{,}000 \times 400$ lb. = 2,400,000 lb. steam @ $0.25 = $600 per yr. $6{,}000 \times 5$ kw. = 30,000 kw.-hr. If purchased power cost is 1c. per kw.-hr., the cost would be $300, making $900 per year saving for

superheaters. Evidently they should be bought.

I wonder if W.W.D. has considered generating the remainder of his power with condensing equipment. If he has the boiler capacity, there would be no cost attached to it except the coal, maintenance, and fixed charges on the generating equipment. For instance, if he has to purchase 90 kw. at 1c. per kw.-hr., costing $5,400 per yr., he could buy a 100-kw. unit for $6,000, having fixed charges of $0.15 × 6,000 = $900.



With a Rankine cycle ratio of 52 per cent and 28-in. vacuum, it would have a water rate of 19.7 lb. Including power for auxiliaries, it would be necessary to generate 100 kw., or 600,000 kw.-hr. per yr. At 19.7 lb. per kw., this would amount to 11,820,000 lb. of steam, costing $2,955 for coal. 5,400 — (900 + 2,955) = $1,545 annual saving, from which only oil and maintenance costs would have to be deducted.

While this is more or less a house of cards, due to lack of data, it might help W.W.D. to chisel some new equipment out of the purchased power bill. There is evidently no excuse for buying any power.

RAYMOND F. BENNETT,
Middletown, Ohio. Crystal Tissue Co.

Prime Mover Pointers

THE steam rates of a 200-kw. generating unit will approximate the following per kw.-hr., based on 125 lb. steam pressure, 100 deg. superheat and 5 lb. back-pressure.

1. Uniflow engine ..... 33 lb.
2. Non-releasing Corliss engine 36 lb.
3. High-efficiency turbine .... 44 lb.
4. Average turbine ..... 49 lb.

In the selection of a generating unit, more attention should be given to the matter of heat balance than to the actual "economy" of the prime mover. Obviously, if the process steam demand is large in proportion to the kilowatt demand, a turbine would "fit" better than a uniflow engine.

Perhaps the best way to answer W.W.D.'s questions is to give a paragraph statement concerning each type in question.

1. The uniflow has the advantage of best initial water rate. It has the highest installation cost. The efficiency falls off with wear of the valve seats. The uniflow is primarily for condensing service; when operated against a back-pressure it is in actuality a counter-flow engine.

2. Maintenance of a Corliss engine is generally lower than on a uniflow. The full to three-quarter load water rates compare favorably with that of a uniflow, but the lower load rates are much higher. The Corliss valve seldom needs attention. It is, however, inadvisable to use as much as 100 deg. superheat because of the valve lubrication problem at high temperatures. The efficiency of a Corliss engine can be considered constant throughout a 15-yr. life.

3. The high-efficiency turbine for this service would be a direct-connected machine of four or six stages. A 200-kw. rating is rather small from the standpoint of an efficient turbine. The maintenance of a turbine-generator unit is lower than on any engine unit.

4. The average turbine for this service would be a geared unit with a turbine speed of 3,600 to 4,500 r.p.m. and a generator speed of 1,200 r.p.m. In the case of a turbine having relatively large clearances between nozzle plate and buckets the efficiency is practically constant throughout its life.

The following method is suggested to enable W.W.D. to select the proper generating unit. Estimate the cost of steam per thousand pounds. Manufacturers will supply the generating set prices. Figure as fixed yearly charges the original investment amortized over a 15-yr. period, interest on the investment (being sure to consider decreased value due to amortization), maintenance, and insurance. Next, from your heat balance calculate the yearly cost of excess steam in each case and add this amount to the fixed charges. The lowest final figure will give a clue to the most economical unit to install.

Los Angeles, Calif. WM. R. DUNN,
Elliott Company.

Steam Consumption Same

STEAM consumption per hp.-hr. of turbines, Corliss and uniflow engines would be so nearly the same in 200-kw. sizes that this consideration might as well be dropped. Steam would be used anyway in processing.

Steam consumption would be around 26 lb. per hp.-hr. The turbine will prove best, because it will deliver a steadier flow and steadier pressure at the process headers, will deliver steam free of oil, will have lower maintenance, will wear more slowly, and there will be no blinking of lights or power surges. Turbines also require less attention, for there are no oil cups to fill and no heavy drag on a cylinder, as in a uniflow.

Should W.W.D. decide to put in superheaters later, the turbine would give 10 per cent greater economy for the first 100 deg. superheat and 15 per cent for the third 100 deg. of superheat without any change in the turbine. But if W.W.D. is considering superheat later, he must be certain to get a cast-steel steam chest instead of a cast-iron one. Cast-iron, because of its porosity, does not expand evenly and sometimes under high superheat will cramp the valve gages, causing the governor to hunt, giving variable speed. Further, if the turbine vibrates heavily, don't accept it—it will only give you gray hairs later.

The Corliss does not take kindly to superheat, because the valves have to have too much clearance for expansion to give good economy before superheat is used. If bored for dry saturated steam, valves expand and cramp in the bore under superheat. Oiling must be watched constantly, pressure will vary at the process header, and there will inevitably be oil carried over. Dies will have to be changed often and the valve gear will wear rapidly, cutting economy. Further, should W.W.D. want to operate condensing, the Corliss would not take kindly to high vacuums. The uniflow drags a heavy piston over the cylinder bottom, thus causes excessive wear. It is higher in speed than the Corliss and wears more rapidly, but gives better light and power, more constant pressure on the process header, and operates better under higher vacuums. I have never used one with superheated steam. My personal preference between engines would be the Corliss.

Detroit, Mich. LEONARD LONG

STRAIGHTENING DIESEL CRANKSHAFTS

ANSWERS to October Question 2

THE QUESTION

WE ARE *encountering a number of new problems in overhauling our many types of diesels, ranging from 1-cyl. horizontals to many-cylindered verticals. We have always "miked" crankshafts in order to test and correct alignment, but we have recently come to the conclusion that our former procedure is not adequate. Dial gage readings taken on the journals of many shafts have shown that many are bent to some extent, and regardless of main bearing level cannot hope to run true. We therefore must develop some more accurate procedure for checking and straightening crankshafts. What procedure can we use and how can we interpret our findings? Is the so-called "hot spot" method of value? If so, who invented it and where and with what success has it been used? Is the resulting shaft permanently corrected? What is the theory and technique? Is the data secured by dial gage readings plottable to permit mathematical or graphical analysis in order to locate points of maximum deflection?*

—E. R. O.

"Hot Spot" Sound; Used for 16 Years

IT HAS been generally understood by those in the mechanical engineering field thoroughly familiar with diesel maintenance, that the method of applying an inside micrometer to points on the inside web surfaces of a crankshaft is of little value, other than in locating roughly a badly misaligned bearing. A dial indicator properly applied along the shaft's length is the only accurate way of locating a bend.

The so-called "hot spot" method of straightening is of great value, as it is the only method today by which a shaft can be accurately straightened. So far as is known, this method was discovered some twenty years ago through an accident in the laboratories of the General Electric Co.

In the practical sense of the word a shaft is "permanently" corrected by proper application of this method. The theory is contraction or actual shortening of the side on which the spot is applied.

As each piece of material, and each crankshaft encountered, responds differently to this procedure, men thoroughly familiar

with its application consider it more of an art than a mathematical science.

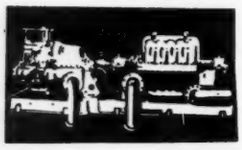
Sherman, Texas. H. W. T.

[EDITOR'S NOTE—*H. W. T. has been using this method of repair for more than sixteen years on all types and sizes of diesel crankshafts, and with notable success.*]

Alignment Is Most Important

IMPROPER crankshaft alignment is probably responsible for more diesel engine operating troubles and maintenance expense than all other combined causes. Experienced diesel engineers, having found this statement to be correct, make frequent checks of crankshaft alignment, utilizing the generally known and approved bridge-gage method supplemented by checking crank-web deflections and level readings of each main journal.

In the majority of instances this method has proven satisfactory, and correct alignment is obtained without difficulty. However, many cases are on record where comparison of the three sets of readings showed inconsistencies. The usual procedure at this point is to scrape one or more bearings in an attempt to secure a satisfactory average between the three sets of readings. After many bearing variations it is found that any reduction in error in one set of read-



ings causes a corresponding increase in the others. From this experience it is assumed that the shaft is bent, making it impossible to secure proper alignment. The engine is reassembled and placed in service. A series of bearing troubles, abnormal liner wear, loosening or breaking of shaft bolts, and in some instances broken crankshafts result. A complete engine alignment and level analysis would have revealed in practically every case that the shaft was not distorted, but the inconsistencies of the readings were caused by poorly fitted bearing ways, a distorted base plate or incorrect setting of the outboard bearing.

Improper fitting bearing ways may be corrected by blueing the bearing support and rolling the shell in position, removing and filing off the high spots.

Compensating for a distorted base plate requires the use of an arbor accurately ground to the diameter of the shaft journals and long enough to reach through at least three main bearings. The arbor is placed in the bearings with a very light coating of Prussian blue on the surface and caused to rotate. A sensitive level is then used on the arbor to determine the high spot. The bearings should be scraped until the arbor is level and satisfactory bearings are secured. The arbor is moved over one bearing and the process repeated until all main bearings have been completed. Using the arbor in the place of the shaft, bridge-gage readings should be made and stamped on the bearing pads for future reference.

The correct procedure of outboard bearing alignment varies with shaft design. It is suggested that this information be secured from the engine manufacturer.

A large diesel engine crankshaft which is distorted to a degree that would require it to be straightened could hardly be repaired outside of the shops of a shaft manufacturer, and even then presents serious complications. It is safe to assume if the shaft left the shop out of alignment that the distortion was machined into it and could not be repaired. Provided the shaft was damaged in service, the distortion would probably be in the form of a twist, and after straightening would require heat-treating to remove internal stresses.

The "hot spot" method of straightening or bending mild steel shafting has been used with satisfactory results for many years. However, it would probably result in a ruined shaft if this process were utilized for *field* repairs of a diesel engine crankshaft.

Daytona Beach, Fla. J. W. KECK,
Sup't. of Generating Stations,
Florida Power & Light Co.

Prevention, Not Cure

BENDING of a diesel crankshaft is a result of improper support. My experience is that gaging between crank webs is the most reliable way to check shaft alignment. Two precautions are essential in getting reliable indications. The webs should be gaged at identical places on both top and bottom centers (scribe the webs where measurements are to be made). Measurement should be made with as near as possible the working weight on the shaft (do not disconnect the flywheel and crankshaft). A shaft in perfect alignment should not show more than 0.001 in. variation between readings when the shaft is at top dead center and at bottom dead center.

Permissible variation varies somewhat with crankshaft diameter, but if variations are greater than 0.003 in., realignment is necessary. I think it is a waste of time to attempt to determine which bearing is low, because all must be adjusted anyhow. The easiest way is to remove the shaft and realign the bearings, using a level and a straight-edge to check. If bearings are in alignment and the shaft is not sprung, it will then run true.

If a shaft is found to be sprung, the best way to straighten it is to put it in a lathe of suitable size, find where the bent section is and then press the bend out with a press. Heating the bent part with oxy-acetylene flame or heavy oil-fired blowtorch will make straightening easier, but before this is done, the makers should be consulted regarding the effect of heat on the steel.

After it is straightened, the shaft should be examined closely for cracks. These are usually to be expected in a sprung shaft. Small ones can be repaired by welding. A severe crack usually means a discarded crankshaft. While it is possible to straighten bent shafts, it is not to be recommended as general practice. It is better to check bearing alignment oftener, watch lubrication, and adjust when needed.

Garden City, England. W. E. WARNER.

Straingage Tests Alignment

A PARTIAL answer to this question appears on page 34 of the April, 1934, *The Locomotive*, in which is explained a method of testing alignment and one for calculating stress recommended by Hartford Steam Boiler Inspection & Insurance Co.

Formerly, engineers knew that appreciable variation in the readings of a micrometer across crank webs at top and bottom positions indicated main-bearing misalignment, and that appreciable misalignment meant constant flexing of the shaft and probably a resulting stress beyond the safe fibre strength of the steel. But where was the danger point?

Hartford sets about answering the question this way: A straingage is placed in position, preferably in punch pricks, between adjacent webs, the spring being set so that its resistance to compression will just hold the gage in place. The crank is then turned slowly to four different positions *with the gage in place*—bottom, top, back and front. At each position a reading is taken. (Obviously, the crank must be kept slightly off center in the bottom position to allow the straingage to clear the connecting rod.)

Maximum bending of the crank webs, as cantilever beams, is then the greatest difference found between any two of the four readings. This formula, based on Hooke's Law, will then give fibre stress in the webs:

Apparent fibre stress, lb. per sq. in.

$$= \frac{43{,}500 \times a \times t}{L^2}$$

in which:

a = Maximum difference between straingage readings in two positions, expressed in mils (a mil is 1/1000 in.).

t = Thickness of crank web, in.

L = Length of crank or ½ engine stroke, in.

This formula assumes that all distortion takes place in one web, the worst possible condition. Actually, distortion may be divided between two webs, in which case the formula is well on the safe side.

When apparent fibre stress in the webs exceeds 20,000 lb. per sq.in. by this method of investigation, the shaft should be taken out of service for expert inspection, for usually dangerous progressive cracks will be found in webs, fillets of the crankpin, or in fillets of the journals.

Our experience with the straightening of diesel crankshafts, with the few cases that have come to our attention, has been unfavorable. It appears that the causes of the shaft becoming bent will sooner or later develop the same defect after the shaft has ben straightened.

It is important to avoid misalignment of the bearings in diesel engines, but this is mainly from the standpoint of avoiding overstress and the formation of surface cracks which eventually lead to complete breakdown of the shaft. Our method of doing this is described above and in the April number of our "The Locomotive."

Hartford Steam Boiler Inspection & Ins. Co. H. J. VANDER EB
Asst. Chief Engineer
Turbine & Engine Division

"Hot Spot" Principle

SOME readers may be unfamiliar with the principle of the "hot spot" method of straightening shafts. Consider, for a moment, a straight shaft in which a hump has been bent. In "hot spot" treatment, the *top* or outside of the hump is heated to a red heat, the inside or bottom of the hump being kept cool. The theory then is that the tension in the bottom of the hump will tend to compress the heated, and therefore plastic, metal at the top so that when the shaft cools, it will automatically straighten out. Obviously, such a method is cut-and-try, suitable for use only by skilled men. —EDITOR.

THE ENGINEER'S BOOKSHELF

Hydraulics

HYDRAULICS (2ND EDITION)—*By Ernest W. Schroder, professor of experimental hydraulics, Cornell University, and Francis M. Dawson, professor of hydraulic and sanitary engineering, University of Wisconsin. Published by McGraw-Hill Book Co., Inc., New York, N. Y. Clothboard covers. 429 pages, 6x9 in.; 13 tables; 206 illustrations. Price, $3.50.*

This book was originally written to supply a nucleus for a basic course in the hydraulics of engineering and not as an exhaustive treatise on one phase of hydraulics. In the second edition, this basic idea has been continued and the treatment revised and enlarged to include advances made in the art during the last seven years. In many places the text has been altered to give clearer presentation and many more illustrative problems have been worked out.

More formal use of Bernoullis theorem has been made, particularly in the examples for the flow in pipes. Ordinary methods and formulas for the flow in pipes are treated in one consolidated chapter, and a new more general treatment of viscous and turbulent flows is given in another.

Parallel use of the Kutter and Manning formulas is a feature in the chapters on flow in open channels. Hydraulic jump and the Parshall flume are presented in a new appendix, while another appendix contains experimental data on orifices formerly given in the body of the text. About 50 pages have been added in revision of the book, but the new treatment should make the subjects easier for the student to grasp and of greater value as a reference on hydraulic problems.

Diesel Handbook

DIESEL ENGINEERING HANDBOOK (7TH EDITION)—*Editor, L. H. Morrison, Associate Editor, T. A. Burdick. Published by Business Journals, Inc., 192 Lexington Ave., New York, N. Y., 236 pages, 9x12 in. (plus 84 pages of advertising); Flexible fabrikoid covers. Illustrated and indexed. Price, $5.*

This is a good job, with particular emphasis on those important elements in any diesel plant—the auxiliaries, particularly cooling towers, temperature and pressure indicators, exhaust systems. The book is much larger than conventional handbooks, with the advantages of larger type and clearer illustrations.

Inevitably many illustrations and some text have been previouly printed, but the present treatment is disinctive, the approach new and refreshing, the regrouping carefully and comprehensively done. The fourteen chapters are really individual essays; the usual dry textbook atmosphere is totally lacking. Chapters are: The Diesel Engine (13 pages), Diesel Production and Economics (16 pages), New Diesel Engines (24 pages), Supercharging Turbocharging and Blower Scavenging (7 pages), Diesel Lubricating Oils and Fuels (9 pages, plus 8 on testing centrifuging and filtration equipment), Plant Planning Installation and Starting (22 pages), Water Cooling Systems (20 pages), Electrical Equipment in Diesel Stations (22 pages), Intake Exhaust and Starting Equipment (8 pages), Fuel and Lubricating Oil Handling & Equipment (14 pages), Operation and Maintenance (27 pages), Keeping of Plant Records (2 pages plus 10 pages of forms), Questions and Answers for the Diesel Engineer (8 pages), Diesel in Transportation (23 pages), Engine-room Maxims (1 page), Advertising (84 pages).

Power Metering

ELECTRIC POWER METERING (1934)—*By Archer E. Knowlton, associate editor, ELECTRICAL WORLD. Published by McGraw-Hill Book Co., Inc., 330 West 42nd St., New York, N. Y. Clothboard covers, 340 pages, 6x9 in. 13 tables; 215 illustrations. Price, $4.*

Metering of electric power has attained an importance second only to generation, transmission and application. Accurate metering requires sources of error be taken into account that may be considered negligible in other branches of the electrical industry. It is from the viewpoint of the technically trained meter engineer that this book has been written.

The treatment covers the basic principles of energy and power metering, coupled with practical methods of kilowatthour, reactive, demand, telemetering and totalizing applications. Terminology of the metering engineer is used, and clarifying discussions given on obscure phenomena in instrument transformers, induction meters, unbalanced systems, wrong connections, non-concordant demand measurements, polyphase systems and technique of meter testing.

The book has been written as a textbook of practical fundamentals on electric power metering that had its beginning in advanced short courses for electrical meter engineers, conducted by the author for several years at Yale University. This work was done at the instance of and in cooperation with successive metering committees of former National Electric Light Association. For the meter engineer and senior electrical-engineering student the book contains a wealth of information.

Career

CHOOSING A CAREER—*Edited by George Bijur. Published by Farrar & Rinehart, Inc., New York. Clothboard cover. 274 pages, 5¼x8¼ in. Price $1.75.*

When they asked for a copy of this book for review, the editors assumed that the career of engineering would be included among the 28 listed. This, however, is not the case. The book has no section dealing with engineering, nor for that matter any dealing with medicine, law or architecture. The preface explains that these particular professions require such arduous preparation that only a few of the readers would be interested.

Nevertheless, we think it worthwhile to bring "Choosing a Career" to the attention of *Power* readers. It will interest some of them to know what opportunities are available in such fields as finance, foreign trade, government service, building, railroading.

The book is composed of speeches at the first Choosing a Career Conference for men and women, held early this year in Newark, N. J. It is an extremely interesting book, not only for the young man who must make his own choice, but also for his older brother who has been through the mill and is frequently asked for advice. How can one advise for or against engineering without knowing the alternatives?

The 28 fields are represented by men of national reputation. There is much less soft soap and much more plain talk than one might expect. Very interesting!

BRIEF REVIEWS

A.S.M.E. MECHANICAL CATALOG (1934). *The regular 24th annual volume, including an index to manufacturers of industrial equipment, materials and supplies. Published by the American Society of Mechanical Engineers, 29 West 39th St., New York, N. Y.*—Data on products of 665 companies.

PRACTICAL EVERYDAY CHEMISTRY (1934). *By H. Bennett, F.A.I.C., editor-in-chief of "The Chemical Formulary." Published by the Chemical Publishing Co., 175 Fifth Ave., New York, N. Y. 305 pages, 5½x8¼ in. Clothboard covers. Indexed. Price $2*—As Frederick Krassner, chief chemist at the U. S. Naval Base, Brooklyn, N. Y., says, this book "tells how to make everything but love and little green apples." It is chock full of formulas of every conceivable kind. Among those that will interest power engineers are: adhesives, lacquers, paints, varnishes, lubricants, construction materials, plating, polishes, abrasives, soaps, and cleaners. There are also eight pages of handy tables.

CONDENSERS, FEEDWATER HEATERS, EVAPORATORS AND BOILER FEED PUMPS (1934). *A report of the Turbines, Auxiliaries & Piping Subcommittee of the Prime Movers Committee, Edison Electric Institute. Published by the Institute, 420 Lexington Ave., New York, N. Y., as Publication B3. 22 pages, 9x12 in. Price 45 cents to members, $1.15 to non-members*—Regular annual report, including users' and manufacturers' statements.

THE ELECTRIC LIGHT AND POWER INDUSTRY IN 1933 (WITH CURRENT FIGURES TO JUNE 30, 1934). *Statistical Bulletin No. 1 (old series No. 10), Oct., 1934. Published by the Edison Electric Institute, 420 Lexington Ave., New York, N. Y. Price 30 cents to members, 75 cents to non-members*—28-page annual report. Ask for Publication B9. Includes principally utilization statistics, although there are several tables on fuel used, electricity generated, etc.

WHAT'S NEW IN PLANT EQUIPMENT

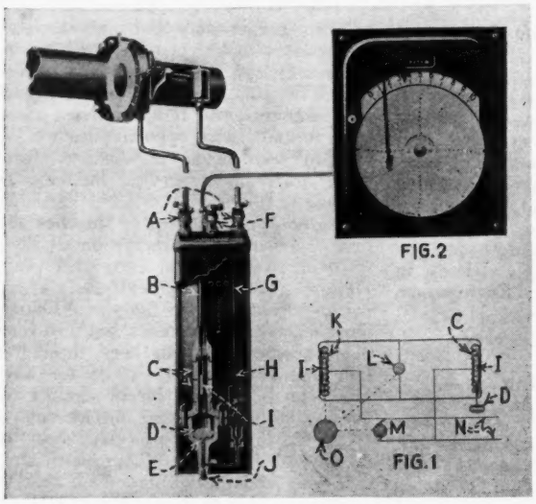


FIG.2 FIG.1

Pipe Flow Meter

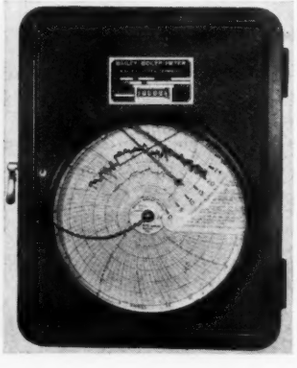
Indicating, recording and integrating elements are powered from external source, thus do not lessen accuracy. Flow through pipeline causes float carrying soft-iron armature and resting on mercury in U-tube to be displaced, this being balanced electrically by shifting a similar armature in recorder, both armatures being surrounded by inductance coils of a bridge circuit carrying a.c. Unbalance deflects boom of a sensitive galvanometer which directs application of power to shift recorder armature until boom returns to neutral. Value recorded when balance is regained. Movement of 0.001 in. in transmitter armature, corresponding to 0.01 per cent change in rate of flow, will be registered. Unit takes 25 watts, and is not affected by voltage variations or other electrical factors, as no current is flowing when recording is done. No over-shooting, even when changes are rapid. Uniformly spaced graduations on charts. Seven interchangeable manometer tubes of different ranges provided to gain full scale deflection under particular maximum and minimum flow conditions. Transmitter may be several miles from receiver. Unit easily checked and recalibrated. Integration or flow at least once a minute, counter reading directly. In illustration: *A* meter cut-off valves, *B* high-pressure manometer tube, *C* transmitter coils, *D* float, *E* overload check valve, *F* equalizing valve, *G* low-pressure manometer tube, *H* calibrating rod, *I* soft iron armature, *J* drain valve, *K* receiver coils, *L* sensitive galvanometer, *M* motor, *N* applied a.c., *O* relay adjusting mechanism. To be shown at Power Show, Booths 82 and 83, of the Paul B. Huyette Co., Inc. Made by:

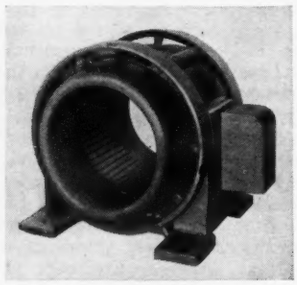
Cochrane Corp., Philadelphia, Pa.

Industrial Boiler Meter

Records steam flow from boiler, air flow for combustion and flue-gas temperature on one 12-in. chart. Also indicates steam flow on porcelain-enameled scale and integrates total steam flow on 6-digit counter. Dust and moisture-proof steel case for flush front or surface mounting, simplified and powerful steam-flow mechanism with interchangeable head chambers (to avoid service interruption if orifice must be changed). Air-flow mechanism gives quick, easy and accurate adjustment. Boiler damper or fuel control is adjusted until steam flow and air flow coincide. Flue gas temperature records show condition of boiler baffles and efficiency of heat transfer through tubes. To be exhibited at Power Show, Spaces 54 and 55.

Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio.





Squirrel-Cage Motors

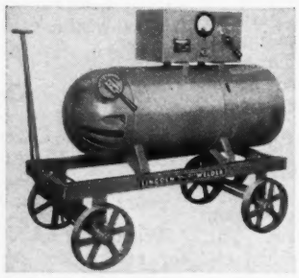
"Seal-Clad" motors have open-type construction with permanent coil protection. Hard, smooth, Bakelite shields over stator coils for protection. Ratings up to 25 hp., 1,800 r.p.m. Cast-steel frames, twistless stators, silver-brazed rotor, sleeve or anti-friction bearings.

Allis-Chalmers Mfg. Co., Milwaukee, Wis.

A.C. Motor-Generator Welder

"Shield-Arc A.C." takes 2- or 3-phase a.c. at standard voltages and frequencies and converts it into a.c. of lower voltage and at that higher frequency most suitable for arc-welding with either heavily coated or washed electrodes. Higher frequency gives more stable arc, less magnetic blow, easier starting. Less spatter loss, greater density in multi-pass welding. Better power characteristics from line (p.f. claimed double that of transformer type machine). Portable and stationary motor-driven models in two sizes, smaller for continuous welding with $\frac{3}{32}$- to $\frac{5}{16}$-in. electrodes, larger for electrodes $\frac{1}{8}$ to $\frac{3}{8}$ in. Wired for 220, 440 or 550 volts, 2- or 3-phase 50 and 60 cycles. Claimed to use less current than transformer type.

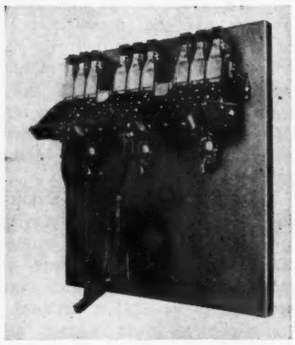
Lincoln Electric Co., Coit Rd. & Kirby Ave., Cleveland, Ohio.



Suction Hose

Woven tubular reinforcement of strong cabled cotton cords and wire makes this light hose which will not collapse. Smooth lining of specially compounded rubber. If crushed, can be reshaped with mallet, and can be connected easily to standard couplings on job. Does not require soft ends. Known as "Delmar"; all sizes to 4 in.

Electric Hose & Rubber Co., Wilmington, Del.



Heavy-Duty Circuit Breaker

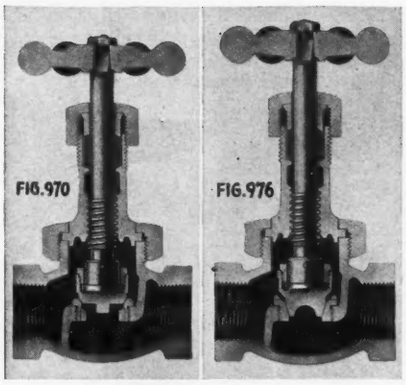
Type HD air breakers rated 5 to 10,000 amp., 750 volts a.c., 600 volts d.c., live or dead front, steel enclosed. Will carry rated current continuously with temperature rise not over 20 deg. C. on contacts. Will open circuit at highest speed so far possible with air-type breaker. Interrupting capacity 120,000 amp. with current 5,000 amp. or greater. Simple, sturdy, foolproof, low maintenance. Stationary latch enables breaker to withstand heavy mechanical shocks. Silver-faced contacts if desired. Steel parts of non-magnetic alloy. Single-pole breakers have straight handles, multipole breakers, spade handles. Long calibration scale.

Roller-Smith Co., 233 Broadway, New York, N. Y.

Protective Coating

"Plicote" is very resistant to chemicals—tanks coated with it withstand action of 50% caustic solutions at elevated temperatures. Brine tanks also coated with success. Provides hard, tenacious film which is also homogeneous and flexible. Suitable for water storage, etc., because tasteless, odorless, nontoxic. Also withstands saponification in painting concrete floors.

Watson-Standard Co., Pittsburgh, Pa.



Extra-Heavy Bronze Valves

These regrind-renew valves made in globe and angle patterns. Figs. 970-973 fitted with nickel-alloy seat ring and disk; Figs. 976-979 with nickel-alloy seat ring and plug. Plug-seated design recommended for throttling or extremely severe service. All valves union bonnet type in sizes to 2 in. In 2½- and 3-in. sizes, valves have bolted bonnet. Screwed-end valves recommended for 300-lb. steam and 500-lb. oil, water and gas. Flanged-end valves for 250-lb. steam and 400-lb. oil, water or gas. Diameter of disk or plug scientifically correct in relation to seat, permitting repeated regrinding without scoring or grooving disk. Stuffing boxes very deep, using lubricated and graphited asbestos packing. Bronze gland or follower permits tightness with slight pressure on packing nut and reduces friction. Bodies electric-furnace bronze, with free passages. Manganese-bronze spindles have Acme threads. Designed so that fluid passing through does not contact spindle-operating threads with valve full open. Supplement to Jenkins Catalog 23.

Jenkins Bros., 80 White St., New York, N. Y.

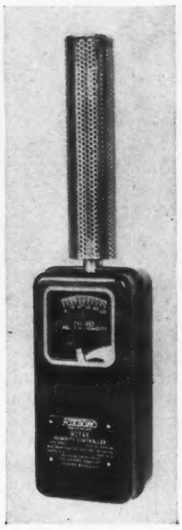
Electric Tape

Goodrich mending and electric tape is 90 per cent pure rubber; single thickness has tested to 8,000 volts. Tested and listed by Underwriters' Laboratories. May be applied as a cigarette is rolled rather than spirally, to save time and tape.

B. F. Goodrich Co., Akron, Ohio.

Indicating Humidity Controller

"Rotax" electrically operated indicating relative humidity controller uses solenoid valves and motor valves on water, air or steam lines. Relay set inside case and can be used to control



unit heaters, dampers, air washers, etc. Contacts have uniform pressure and self-cleaning action. Range 0-100 per cent R.H. and between 10 and 120 deg. F. Also room or duct temperature controllers in same style case for industrial use. Interlocking electrical circuits when required. Bulletin 184.

Foxboro Co., Foxboro, Mass.

Oil Circuit Recloser

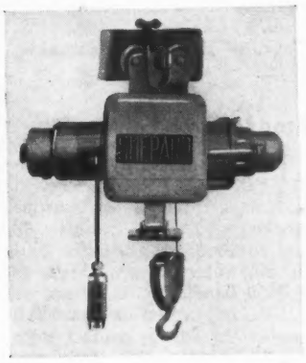
Single-pole outdoor automatic oil circuit reclosers. Designated as Type FP-19, for circuits from 2,200 volts to 7,500 volts and 50 amp. continuous loads. Only two connections to distribution circuit, no control power necessary. Device opens promptly on short circuit, then closes automatically after several seconds, remaining closed if fault is removed and resetting itself for next emergency. If fault is not cleared, device will reopen, and will go through this cycle three times. If after three cycles, short is not cleared, device will lock itself open and indicate its position by target. Manually reclosed.

General Electric Co., Schenectady, N. Y.

Brazing Flux

"Handy Flux" for brazing either ferrous or non-ferrous metals. Has lower melting point than other similar fluxes, works efficiently over wide temperature range, greater solvent action on wider variety of oxides. Less tendency to ball up or bubble; slag washes off readily. ½, 1 and 5-lb. jars, in paste form.

Handy & Harman, 82 Fulton St., New York, N. Y.



5-Speed Pushbutton Hoist Control

Five speeds, controlled from one button, are featured in this selective 5-speed pushbutton controller for cranes and hoists. First speed is "creeping," others progressively to full speed can be felt as distinct points as button is depressed. When button is released gradually, same series is gone through in reverse order. On heavy loads, fewer speeds are available; thus on very heavy loads, load will not move until third or fourth switch-point. Load can be "jogged" between two points where lower point will not keep load lifting and upper one is too fast. Individual pushbutton controllers available for various crane motions—bridge, trolley and hoist. Unit is compact and easily mounted. Similar units and control for a.c. and d.c. Two sizes: Class 1, 3 hp., Class A, 7½ hp.

Shepard Niles Crane & Hoist Corp., 388 Schuyler Ave., Montour Falls, N. Y.

Grease Cartridge

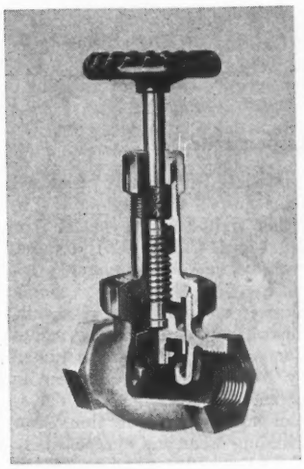
1-lb. factory-loaded grease cartridges for new type gun. Cartridges have sliding bottoms which act as plungers to feed grease into high-pressure chamber in gun nose. Cartridges may be interchanged when different type grease is required, since plunger base and special head seal. Lubricant range from fluids to heavy grease. Non-refillable. Developed by Standard Oil Co. (Ind.) and Bendix Aviation Corp. subsidiary:

Lubrication Corp., 910 S. Michigan Ave., Chicago, Ill.

Geared-Head Turbo-Blowers

Centrifugal compressor using gearmotor for speed increase, thus giving blower running at higher than motor speeds, with consequent reduction in size and better performance. Pressures 0.75 to 3.0 lb. gage, volumetric capacities corresponding to motors from 3 to 30 hp.

Allis-Chalmers Mfg. Co., Milwaukee, Wis.



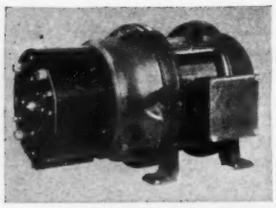
Globe and Angle Valves

Renewable bronze. Radial seat between body and bonnet for tight joint alignment and longer wear. Seat drawn to tight joint by union nut without sliding or scraping of seat surfaces. Long-fiber asbestos disk ring, standard for interchangeability with other types if desired. Stem rolled bronze rod with at least five full Acme threads always in contact with bonnet. Protected top seat above stem threads makes for easy repacking under pressure. Ventilated, malleable-iron handwheel. Wheel locking nut below hand level and held by lock washer. All parts interchangeable.

Fairbanks Co., 393 Lafayette St., New York, N. Y.

Disk-Type Electric Brake

Compact, smooth-acting, designed for mounting on many types of motors. Suitable for applications requiring no more



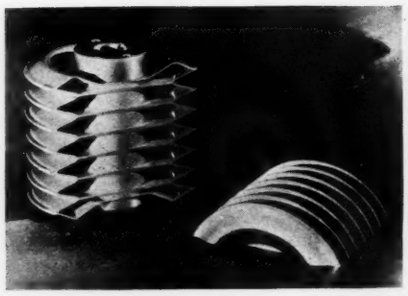
than 50 lb.-ft. of braking torque continuously or 75 intermittently. Brake also available individually for floor-mounting in application to motors already in service. Construction similar to multiple-disk clutch, calibrated helical springs forcing non-rotating disks against rotating ones splined to motor shaft. Magnetic system ordinarily holds springs back. Small airgap limits current inrush and consequently power consumed. Torque and lining wear adjustments. Quick, smooth action, low braking pressure and long life.

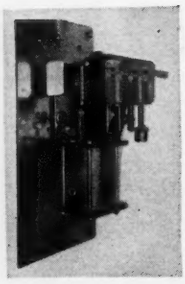
General Electric Co., Schenectady, N. Y.

Lubricator

Model ET totally enclosed lubricators are available in either sight-feed (Type SF) or blind-feed (Type BF) designs, both using single-plunger principle. In Type SF, single plunger takes oil from reservoir, measures it and forces it to delivery point. Plunger actuated by rocker arm traveling on an eccentric. Rocker arm drives plunger in straight line, thus avoiding wear due to side thrust. On discharge stroke, oil is forced to delivery point under pressure, and at same time oil is drawn from reservoir for next delivery. On downstroke, oil in suction chamber is forced through sight-feed intake nozzle into sight-feed chamber, then to discharge side of plunger, which is separate from suction side of pump. Exact amount of oil passed to sight-feed is delivered at each stroke. No pressure or vacuum in feed glass, which only gives evidence of operation and keeps foreign substances out of delivery lines. Mounted close to discharge line to protect against breakage. Adjustment from one to ten drops per stroke against varying pressures up to 2,000 lb. Type BF is similar except sight-feed is omitted. Oil feed regulation accomplished by changing length of plunger stroke. Glycerine or blinker sight-feeds or pump-plunger stroke-length indicator available for use with this type. Clutch drive. All working parts run in oil. Reservoir capacities 2 to 8 pints.

Hills McCanna Co., 2349-59 Nelson St., Chicago, Ill.





Reinforced Sheave

Duro-Brace Texsteel sheave has outside walls reinforced by convex steel plate which avoids distortion. Welded at rim and web for strength and has interior grid-type construction for rigidity.

Allis-Chalmers Mfg. Co., Texrope Division, Milwaukee, Wis.

Bronze Gate Valves

Inside-screw, traveling-spindle gate valves with screwed and flanged ends, for various working pressures. Figs. 47 and 48 for 125-lb. steam or 200-lb. oil, water or gas. Figs. 49 and 50 handle 150-lb. steam or 225-lb. oil, water or gas. All bonnet threads in contact with spindle at all times. Body cast electric-furnace bronze with free passages. Cast-in guides keep wedge in line with seat. Wedge out of line of flow when valve is full open. Double-faced solid wedge and precision machined seat for tight closure. Extra-deep stuffing box. Valves can be repacked under full pressure and fully open. Supplement to Jenkins Catalog 23.

Jenkins Bros., 80 White St., New York, N. Y.

Trip-Free Solenoid Mechanism

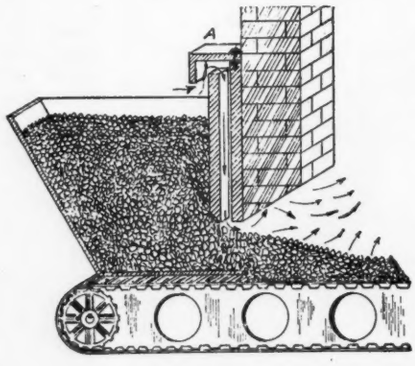
Compact, trip-free, d.c. solenoid mechanism operates electrically small indoor oil circuit breakers. This Type MS-5 has potential trip coil for remote tripping, also provision for three instantaneous or time overcurrent trip coils. Current trip coils, when energized, release mechanism by direct-acting trip mechanism to open breaker. Emergency manual operation by removable lever. If operated from a.c. source, suitable copper-oxide rectifier and accessories are used in conjunction.

General Electric Co., Schenectady, N. Y.

Close-Coupled Centrifugal Pump

This line of close-coupled, side-suction centrifugal pumping units called "Standard-Motormount," is so designed that any make of standard ball-bearing motor of open, enclosed, splash-proof or explosion-proof types can be used. Design of motor and pump shafts avoids necessity for special motor end bells or shaft. Pump and motor on substantial base plate, avoiding overhang of either. Cradle mounting of pump permits expansion when handling hot liquids without disturbing alignment. Complete units in stock. At 1750 r.p.m., capacities 5 to 650 g.p.m.; at 3,500 r.p.m., capacities 25 to 250 g.p.m. Bulletin 4150.

Deming Co., Salem, Ohio.



Stoker Air Plate

V.M. air plate *A* allows thin film of air to enter at top of fuel pot inside and into fuel along entire width of hopper. Angle iron above prevents coal from getting in. It helps ignite coal and gases at very front of furnace, bettering combustion and steam generation avoiding smoke and saving fuel. Can be used on any type overfeed stoker.

V.M. Engrg. Co., 916 G St., N.W., Washington, D. C.

Trap-pump Unit

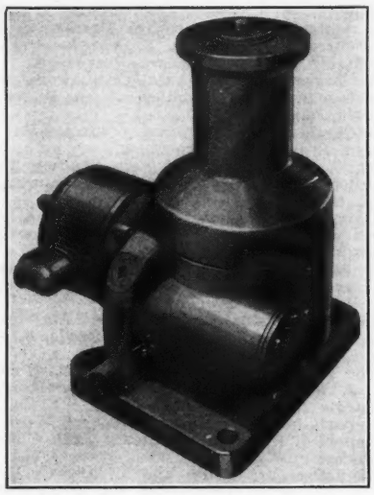
"Electrap" is pressure-equalizing, motor-driven boiler-feed and condensate-return unit requiring only ⅓-hp. motor for 100-hp., 125-lb. pressure unit. Combination of two-valve return trap and motor-driven low-head centrifugal pump. When condensate fills trap, vent valve closes and steam valve opens, admitting steam at boiler pressure, and mercury switch trips to start pump. As pressure in trap is equalized with that of boiler, pump has only to raise water to boiler and overcome pipe friction. When trap has emptied, steam valve closes, vent opens and motor stops. Unit especially suited for gravity systems, will return both low-pressure and high-pressure returns, also feed make-up water and heat it as it goes through trap. Four sizes for boilers of 200, 400, 600 and 10,000 sq.ft. and two series, 60-lb. and 125-lb. maximum pressure.

Johnson Corp., Three Rivers, Mich.

Tape and Splicing Compound

"Gold Seal" line of friction tapes and splicing compounds includes regular commercial grades as well as special. Packed in 1-, 2-, 4- and 8-oz. rolls. Friction tape strong, "tacky," free from pinholes, non-ravelling, high insulating qualities. Splicing compound is high-grade rubber insulating tape which fuses immediately. Either Cellophane or tinfoil wrapper. Samples.

Jenkins Bros., Rubber Division, 510 Main St., Bridgeport, Conn.

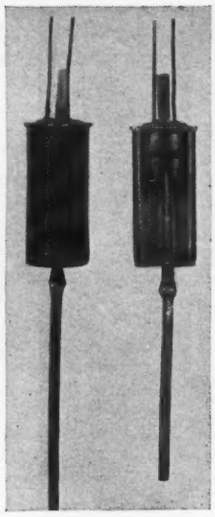


Motorized Car Spotter

Vertical-capstan type electric unit now furnished with motor attached direct to side of housing, eliminating base plate and shaft coupling. Housing includes helical-gear reduction at motor and worm-gear set, running in oil. Motor is high-torque fully enclosed type, easily removable with pinion. Two sizes, smaller with pull of 5,000 lb., larger 10,000 lb. Booklet No. 1392. To be shown at Power Show.

Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill.

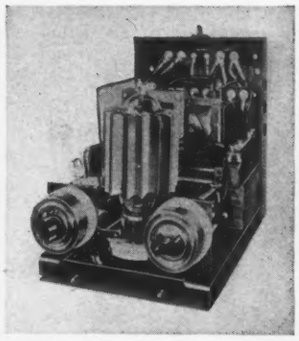
All-Metal Vacuum Switch



Made almost entirely of steel and designed to take advantage of absence of an arc when breaking a circuit in high vacuum, these vacuum switches are only ¾ in. in diameter and 1½ in. long. Operated by a fraction of an ounce pressure, unit can interrupt as much as 5 hp. as fast as 30 times per sec. Designated as Type Fa-6 and rated at 10 amp., 250 volts d.c. or 440 volts a.c., or 5 amp. at 500 volts d.c. Steel chamber is hydrogen-copper brazed and exhausted to high vacuum through hollow steel operating stem passing into vacuum contact chamber through thin steel endwall flexible enough to permit slight motion for contact. Leading-in wires sealed in glass beads inside allow thimbles inserted through opposite and heavier endwall. Thus can withstand severe shock and vibration.

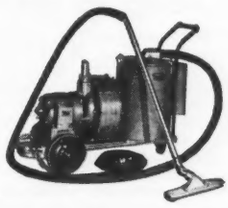
General Electric Co., Schenectady, N. Y.

A.C. Manual Regulator



For any a.c. circuit where voltage must be manipulated; replaces rheostats, resistances, reactances, transformers. Uses Kathetron tube—a hot-cathode rectifier with control grid *outside* the bulb. It acts as an instantaneously operating switch which can be kept closed for a varying time depending upon voltage applied to insulating band around it. Available in two forms: in one current permitted to pass to load is varied as desired, in other voltage may be raised or reduced over range of 50% each way. Range of first type is from slightly below normal voltage applied to load to below 25% of normal. Very efficient, easily applied for remote control. Magnitude of voltage applied to load circuit is practically independent of load. Tubes have 5,000-hr. life. Almost any rating desired.

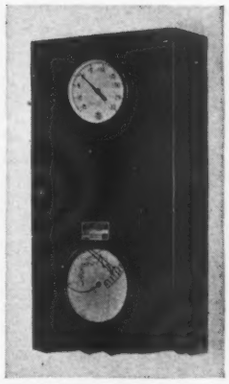
Roller-Smith Co., 233 Broadway, New York, N. Y.



Vacuum Cleaner

"Invincible" industrial truck vacuum cleaner cleans floors, walls, ceilings, overhead structures, pipes, feeders, hoppers, boilers, auxiliaries. Handled by one man. Has dust separator which removes entrained material before air strikes fan blading. Exhausted air is filtered three times. Dirt collected in metal container at floor level, easily emptied. 4-stage turbine exhauster with 3-belt Texrope drive on 5-hp. motor produces 70-in. water gage suction and volume of 265 cu.ft. per min. Weight 550 lb., carried on roller-bearing, swivel-wheeled carriage. Height 57 in., width 21, length 27.

Invincible Vacuum Cleaner Mfg. Co., Dover, Ohio.



Boiler Water Meter

Indicates and records both boiler water level and feedwater flow. Is combination of standard fluid meter (to indicate, record and integrate feedwater flow) and 12-in. indicator with dial-type scale for boiler water level. Indicator mounted directly above recording meter on small feedwater panel. Checking of combination record will show source of erratic or faulty operation, particularly with boilers having small water-storage space where changes in load may cause slugs of water to be carried over into superheater.

Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio.

Barrel Rack

Barret Rockerack permits one man to put drums and barrels into convenient position for draining. Uses new arrangement for tilting and lifting that is easier, quicker, safer. "Toes" of rack are placed under drum, thus not necessary to lift barrel in tilting—it helps tilt itself. Two styles, Model 18 without casters, 18W with casters. Handles barrels or drums of 30 to 55 gal., bilged or straight sides, steel or wood.

Barrett-Cravens Co., 3255 West 30th St., Chicago, Ill.

NEW BULLETINS

Steam-Jet Refrigeration — Elliott Co., Jeannette, Pa. 16-page bulletin G-5, "Steam Jet Vacuum Cooling Equipment;" describes units, principle, hook-ups, component parts, cycle and applications in air-conditioning and process cooling. Write to Heat Transfer Dept.

Pumps—Worthington Pump & Machinery Corp., Worthington Ave., Harrison, N. J. Eight new bulletins on pumps, particularly for petroleum industry: WP-1027, Equipment for the Refinery and Natural Gasoline Plant; W-111-B6, HiVol Piston Pumps; W-101-B3, Horizontal Duplex Piston Pumps—Type VB; W-101-B4, Horizontal Duplex Piston Pumps—Type VD; W-312-B1, Centrifugal Pumps for Refineries—Type LT; W-318-B2, Centrifugal Pumps for Refineries—Type UT, Two-Stage; W-318-B3, Centrifugal Pumps for Refineries—Type UV, Four-Stage; W-318-B1, Centrifugal Pipe Line Pumps—Types UW, UX and UY.

Feed-Water Conditioning — Cochrane Corp., Philadelphia, Pa. 48-page Bulletin No. 689 not merely describes this company's hot process softener, but constitutes an up-to-date textbook on hot-process, cold-process and zeolite softeners, interpretations of water analysis, molecular and equivalent weights of substances, and chemical reactions. It gives latest information on operation of high-pressure boilers, including use of phosphate in water conditioning.

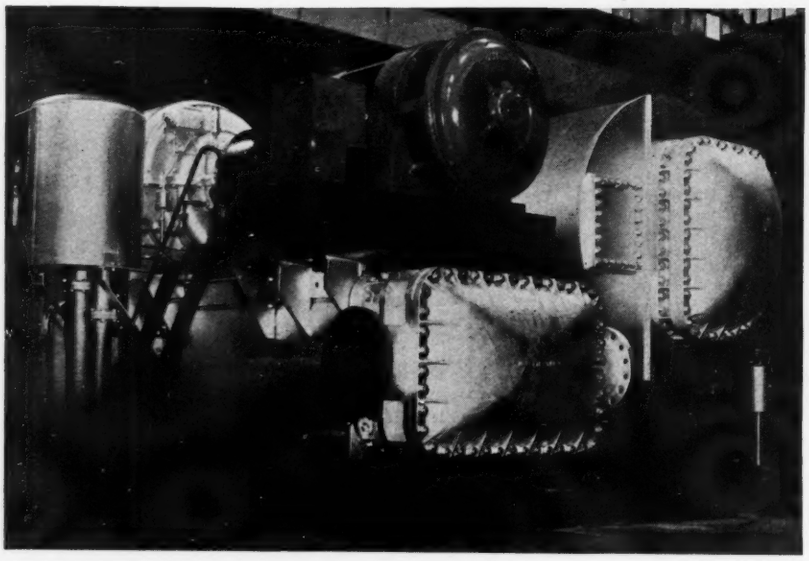
Graphite—Acheson Colloids Corp., Port Huron, Mich. Series P, No. 210, Technical Bulletin on "Graphite—Its Several Fundamental Types." Also Technical Bulletin No. 230.1, "Concerning Colloidal Graphite and the Forms in which this Unique Material is Available."

Boiler Meters—Bailey Meter Co., 1050 Ivanhoe Road, Cleveland, Ohio. 32-page bulletin, "Savings Effected by Bailey Boiler Meters," known as No. 44A, is data taken from 23 typical installations covering wide range of boilers, fuels, firing methods and classes of plants.

Throttle Valves—Wayland Co., Ltd., 675 Townsend St., San Francisco, Calif. 4-page bulletin on "Variable-Orifice Throttle Valves," suitable for 300-lb. working pressure and 550 deg. F.

Pressure Recording Instrument—Esterline-Angus Co., Indianapolis, Ind. Bulletin 834, a regular issue of the house organ, "The Graphic," describes pressure-recording instruments, including pressure relays and telemeters made by this company. Also 2-page bulletin, "Save Time and Trouble by Using These Handy Devices," giving accessory equipment for use with meters.

Skating Rink Refrigeration—Carbondale Machine Co., Carbondale, Pa. 4-page circular, "Swimming Pool Skating Rink," describing equipment necessary for converting swimming pool for winter use as skating rink. Also 8-page Bulletin No. 334, "Economical Wort Cooling," describing three-stage and two-stage coolers, and double-pipe beer coolers; also 8-page Bulletin No. 234, "The New Carbondale Alternator Air Agitating System," describing system recently mentioned in **Power.**



WORLD'S BIGGEST ICE BOX

Largest electrical refrigerating machine ever built, equal in capacity to more than 12,000 domestic refrigerators, assembled in shops of Carrier Research Laboratories, Newark, N. J. prior to shipment to South Africa where this machine and three units just like it will be used to air-condition world's deepest gold mine, the Robinson Deep, near Johannesburg, which is 8,380 ft. deep. The machine weighs 100,000 lb., holds more than a ton of chemical refrigerant and contains 1 mile of copper cooling coils. It is 10 ft. high, 18 ft. long, 16 ft. wide, and is driven by a 750-hp. electric motor. It will produce 2,500 gal. of ice water per minute. This refrigerated water is used to cool the air, which will then be forced into the gold mine shaft at the rate of 400,000 cu.ft. per min. The combined capacity of this machine and its two companion units is equivalent in cooling effect to the melting of two thousand tons of ice. When installed in the South African gold mine it will be the largest air conditioning plant on record.

POWER LINES

POWER WEEK COMES 'ROUND AGAIN

11th National Power Show, A.S.M.E., A.W.S., A.S.R.E. and Other Society Meetings Emphasize Trend Toward Cutting Power Costs

POWER Week begins in New York at the time this number reaches its subscribers. Dec. 3-8 marks the annual meeting of the American Society of Mechanical Engineers and the Eleventh National Exposition of Power and Mechanical Engineering—in other words, the Power Show. Dec. 5 to 7 marks the annual meeting and celebration of the 30th anniversary of the American Society of Refrigerating Engineers. Other societies, including the American Welding Society, will be holding sessions during the week.

A.S.M.E. papers of particular interest to power engineers include:

Welding vs. Casting (Welder's Viewpoint), *Everett Chapman, Lukenweld, Inc.*

Welding vs. Casting (User's Viewpoint), *Sol Einstein, Cincinnati Grinders Inc.*

Effects of Slide Leakage in 120-deg. Centrally Supported Journal Bearings, *S. J. Needs, Kinsbury Machine Works, Inc.*

Performance of Large Journal Bearings, *R. Beaudry and L. M. Tichvinsky, Westinghouse.*

Air Flow in Fan Discharge Ducts, *L. S. Marks, Harvard University.*

Pulsating Air Flow, *Neil P. Bailey, Iowa State College.*

Fan Research at Lehigh (Progress Report), *W. E. Somers, Lehigh University.*

Status of Test Code for Fans, *M. C. Stuart, Lehigh University.*

Intake Orifice and Proposed Method for Testing Exhaust Fans, *N. C. Ebaugh and R. Whitfield, Georgia School of Technology.*

Application of Central Station Practice to Domestic Heating, *M. K. Drewry, Milwaukee Elec. Ry. & Light Co.*

Current Practice in Pressures, Speeds, Clearances and Lubrication of Oil-Film Bearings, *H. A. S. Howarth, Kinsbury Machine Works.*

Fatigue of Shafts at Fitted Members, *R. E. Peterson and A. M. Wahl.*

Strength and Design of Covers and Flanges for Vessel Openings, *T. McLean Jasper, H. Gregerson and A. M. Zoellner, A. O. Smith Corp.*

Discussion of the Status of the Heat Transfer Between Liquid and Gas in Contact, *A. Weisselberg, Consulting Engineer.*

Investigation of Heat-Transfer Rates on External Surface of Baffled Banks, *R. A. Bowman, Westinghouse.*

Movement for the Study of Technical History, *I. N. Lipshitz.*

Flow Distribution in Forced-Circulation Once-Through Steam Generators, *H. L. Solberg, G. A. Hawkins, A. A. Potter, Purdue University.*

Influence of Bends on Obstructions at the Fan Discharge Outlet on the Performance of Centrifugal Fans, *L. S. Marks, J. H. Raub, H. R. Pratt, Harvard University.*

An Investigation of Axial Oscillations of Turbine-Generator Spindles, *J. G. Baker, Westinghouse.*

A Mathematical Solution of Rotor-Balancing Problems, *J. Bromberg.*

Effect of Skewing and Pole Spacing on Magnetic Noise in Electrical Machinery, *S. J. Mikina, Westinghouse.*

Dynamic Balancing of Rotating Machinery in the Field, *E. L. Thearle, General Electric.*

Pulverized-Fuel-Burning Experience at Buzzard Point Plant, *H. G. Thielscher, Potomac Electric Power Co.*

The Economics of Preheated Air for Stokers, *R. E. Dillon and M. D. Engle, Edison Electric Illuminating Co.*

The Relative Grindability of Coal, *Harold J. Sloman and Arthur C. Barnhart, Carnegie Institute of Technology.*

Reports on Steam Tables Research Work.

Report of International Steam Table Conference.

High-Pressure-Steam and Binary Cycles as a Means of Improving Power-Station Efficiency, *Gustaf A. Gaffert, Worcester Polytechnic Inst.*

Fluid-Meter Nozzles, *B. O. Buckland, General Electric.*

Progress Report on Research Work on Dissolved Oxygen, *C. H. Fellows, Detroit Edison Co.*

Navy's Experience with the New Boiler Compound, *R. C. Adams, U. S. Naval Experimental Sta.*

The Test Performance of Hudson Avenue's Most Recent Steam-Generating Units, *P. H. Hardie, Brooklyn Edison Co.*

Ten Years of Stoker Development at Hudson Ave., *J. M. Driscoll, W. H. Sperr, Brooklyn Edison Co.*

Coal Charges for Banking, Lighting, and Burning Out Boiler Units, *George C. Eaton, Edison Elec. Ill. Co.*

Progress in Power (*Reports of Divisions*).

Future of the Large Motorship, *Louis R. Ford, "Motorship."*

A Critical Survey of Published Information Relating to the Embrittlement of Boiler Steel, *Everett P. Partridge and W. C. Schroeder, Bureau of Mines.*

The Solubility of Sodium Sulphate in Boiler-Water Salines as Related to The Prevention of Embrittlement (*Progress Report No. 3*).

The Effect of Solution Composition on the Failure of Highly Stressed Boiler Steel (*Progress Report No. 1*).

Calibration of Rounded-Approach Orifices, *J. F. Downie Smith, Harvard University.*

The V-Notch Weir for Hot Water, *E. S. Smith, Builders Iron Fdy.*

Practical power cost saving will be the keynote of exhibits at the Power Show, and most booths will have simplified presentations which give even the casual visitor a good idea of the product or service offered. Products shown by more than 225 exhibitors will include:

Transmission apparatus, including silent and roller chain drives, flexible couplings, friction clutches, free-wheeling clutches, shaft hangers, blocks, speed and motor reducers, beltings, and belt fasteners.

Instruments, including recording and indicating precision instruments, electric flow meters, thermometers, gauges, mercury switches, proportioning systems, controllers and pressure regulators.

Piping and tool equipment, including amalgamated products, block tin linings, lead linings, pipe threading and cutting machines, gaskets, packings, pumps, pipe hangers, precision tools, hack saws and saw filers.

Electrical apparatus, including relays, rheostats, contactors, dimmers, conduit fillings, insulation testing instruments and photo electric equipment; motors of every type.

Steam plant apparatus, including steam traps, boiler feeders, steam and oil separators, steam draining devices, temperature regulators, condenser tubes and pipe savers.

Air-conditioning and refrigerating appara-

tus, including industrial fans and blowers, industrial and furnace vacuum cleaners, sprayers, dust separators, and cooling and ventilating systems.

Diesel engines and motors of large capacity for heavy work.

Specialties will include filters, refractory bricks and cement, street showers, fountains, water softeners, cleaning machines, and an automatic process for making brine. Publishers will have on display textbooks, foreign technical literature, and the American periodicals active in the field of power production and mechanical engineering.

Largest show for some years, this one is expected to attract more than 40,000 visitors, in spite of the fact that admission is only by invitation, identification as a member of the A.S.M.E., or registration at the Show as a qualified visitor.

A.S.R.E. Celebrates 30 Years

Hotel New Yorker will be the focal point for visitors at the A.S.R.E. convention and 30th anniversary celebration. Included in papers are: Air as a Refrigerant, Air Conditioning and Odor Control, Visual Heat Transfer Measurement, Storage of Meat—A Review of Investigations, The Advancement and Achievements of Quick Freezing, Refrigeration and its Place in the Engineering World (film), The Thermo-Physics of Liquid Refrigerant Controls, Refrigeration in the TVA, Standards and Codes for Small Refrigerating Machines, Beer Dispensing, Progress in Refrigerator Car Practice.

Harry Harrison, of the Carrier Corp., has been nominated for president in 1935, to succeed Alexander R. Stevenson, Jr., of GE. Nineteen charter members of the organization, including D. S. Jacobus of B&W and Henry Vogt of Henry Vogt Machine Co., will be honored at the meeting.

Willis H. Carrier, chairman of the board, Carrier Eng. Corp., Carrier Corp., Carrier Mfg. Corp. and Carrier Engineering Co (London), has been awarded the medal of the American Society of Mechanical Engineers for 1934, for research in air conditioning. He is a past president of the A.S.R.E. and the A.S.H.V.E. Mr. Carrier, pioneer in air conditioning, is the author of many scientific papers, one of which, "The National Psychometric Formulae," published in 1911, presented the theory now accepted as to evaporation of moisture.

Ralph E. Flanders, president of Jones & Lamson Machine Co., and a member of the Business Advisory and Planning Council appointed by Secretary of Commerce Daniel C. Roper, has been awarded the Worcester Reed Warner gold medal for his "contributions to a better understanding of the relationship of the engineer to economic problems and social trends." Mr. Flanders is president-elect of the A.S.M.E.

The Charles T. Main award, carrying an annual stipend of $150, went to Philip P. Self, of Fort Collins, Colo., for a paper on "Air Conditioning—Its Practicability and Relation to Public Welfare," and John I. Yellott, Jr., instructor in mechanical engineering at the University of Rochester, received the junior award for a paper on "Supersaturated Steam." All awards will be presented during the annual meeting of the society.

Furnace Wall Collapses at Boston "El" Power House

One man was killed and four others critically injured at the Boston Elevated Power House, East First St., South Boston, on Nov. 7, when a portion of a brick wall near the top of a boiler furnace, about 15 ft. long by 12 in. thick, collapsed and fell 20 ft., crushing the workmen who were about to erect a staging inside. Several days ago some bricks had fallen from the top of the wall, causing the preparations for repairs.

Multi-Unit Heating Plant Goes into Operation

The unique multi-unit central heating plant, consisting of 120 G.E. domestic oil furnaces arranged to operate automatically in a battery, installed during the past summer at Mount Holyoke College, South Hadley, Mass., and described recently in *Power*, is now in operation. Fifty-three buildings now are heated automatically by 172 furnaces, 24 of the buildings being heated from the central plant. Other buildings around the edge of the campus, are equipped with single furnaces or with furnaces in small groups, the largest covering ten units. A wide variety of heating systems is used—steam, vapor, hot water and conditioned warm air, depending on requirements.

Campus beautification was one advantage, low transmission losses another. The present system is housed in a low building with a short high-velocity exhaust nozzle instead of a stack. Automatic controls operate only as many furnaces as are needed, maintaining a range of pressures that permit most efficient unit operation.

Crawford to Help Gov't Obtain Engineers for Jobs

Col. C. H. Crawford has been selected to represent the four Founder Societies in an effort to aid the Federal Government in obtaining qualified men for engineering work. He will be located in Washington. American Engineering Council will consider further steps at its annual meeting in Washington Jan. 10, 11 and 12, discussing particularly the professional status of engineers and how to push it forward, the public works program, competition of government with private engineers, etc. Meanwhile, the U. S. Department of Labor, in cooperation with the Council and various engineering societies, is making a profession-wide survey to show how engineers have fared through the hard times. Unsigned confidential questionnaire returns from 100,000 engineers will give salary trends, types of employers and duties over the past several years. Data so gathered are expected to aid in apportioning college training, in bettering the engineer's status and in various other ways.

Apparently, unemployment among engineers has declined during the past year, but is still a large problem. Present unemployment stands around 30,000, many of them college graduates. Surveys have shown about 15,000 engineers employed by the Government, as compared with only about 4,000 on the rolls when the present administration took office.

Carbondale and Worthington Consolidate Refrigeration

Carbondale Machine Co., Carbondale, Pa., and Worthington Pump & Machinery Corp., Harrison, N. J., have consolidated their interests in the general refrigeration field, operating in the future as Carbondale Machine Corp. Carbondale Machine will transfer personnel and equipment to Harrison, N. J., and will henceforth operate at the Worthington plant.

Municipalities Favor Public Ownership of Power

Most election battles over public ownership of electrical utilities went in favor of bond issues and authorizations to increase the country's total of publicly owned electric plants. Memphis voted a $9,000,000 bond issue to "purchase or erect" a plant to distribute TVA juice. Sacramento voted $12,000,000 for a steam plant. Muskogee, Okla., authorized $1,125,000 in city bonds for a public light and power system. Wapakoneta, Ohio, went 2 to 1 for a municipal plant. St. Paul turned down a franchise to Northern States Power Co. The State of Washington approved a referendum to allow cities to sell power outside their borders.

On the other side, Oregon turned down a Grange measure to build publicly owned power lines. Morenci, Mich., vetoed a plan to borrow $146,000 to put up a city-owned power plant. Municipal ownership met defeat at Rifle, Colo., for taxpayers voted both against building a municipal plant and issuing bonds to build one.

Acetylene Association Meets in Pittsburgh

High spot of the 35th annual convention of International Acetylene Assn. at the William Penn Hotel, Pittsburgh, Nov. 14-16, was the industrial drama, "Profits of Progress," at the Davis Theatre, on the evening of Nov. 14. The theater, which seats 2,100 people, was filled to capacity, plus a hundred people standing and more than 200 were turned away. This program is unique in the history of technical society meetings, yet at the same time offered sound information on the oxy-acetylene process.

One complete session of the meeting was devoted to pipe welding and testing, with papers on: "Dependability of Commercial Methods of Testing Welds and Welded Products," "Production Methods Used in Welding for Construction Purposes," and "Pipe Welding." There was also a complete session on Education and Safety in Welding, including the following papers: "What the Young Engineer Should Know

About Welding," "How Common Safe Practice Produces Unnecessary Hazards in the Application of Oxy-acetylene Welding," "Trade Practices in Oxy-acetylene Welding and Cutting," and "Prevention of Fires Resulting from Use of Oxy-acetylene Process."

Horizontal Heating Boilers

A proposed Simplified Practice Recommendation, covering steel horizontal-firebox heating boilers, has been mailed to all interests for their consideration and approval, according to the Division of Simplified Practice, National Bureau of Standards. This recommendation lists 19 sizes of boilers ranging from 1,800 to 35,000 sq.ft. of steam radiation, and from 2,880 to 56,000 sq.ft. of water radiation for handfiring. Nineteen ratings are also given for boilers mechanically fired, ranging from 2,190 to 42,500 sq.ft. of steam radiation, and from 3,500 to 68,000 sq.ft. of water radiation. It also includes heating surface and grate areas for each size of boiler and furnace volume, size of outlet and number and size of safety valves from various types of fuels. If approved by industry, it will be issued as simplified practice recommendation R157, effective from July 1, 1935.

Electrical Manufacturing

Wage earner employment in the manufacture of electrical machinery, apparatus and supplies increased nearly 50 per cent during early 1933, but decreased in the fall, according to a report of the Bureau of the Census. Total value of products manufactured by establishments engaged primarily in electrical manufacturing amounted to $549,983,599 in 1933, as compared with $995,010,213 in 1931 (last previous census year). Of this, $16,298,418 was in generators and motor-generator sets in 1933, as compared with $34,437,877 in 1931. The figures for motors were $55,703,075 and $95,002,893.

Seven Men Die in Blast of Cotton Gin Boiler

Seven men were killed Sept. 7 at Neal, Ga., by explosion of a cotton-gin boiler, fired up to gin the first bale of the season. The gin was owned by Williamson & Co.

Hawk's Nest Penstock Fails Under Test

On the morning of Nov. 1, during a test of a steel manifold and penstocks of the Hawk's Nest hydro-electric plant of Electro Metallurgical Co., on the New River, near Gauley Junction, W. Va., a failure occurred in the manifold branch leading to one of the five 14-ft. penstocks. This failure resulted in the death of five men engaged in the test, four of them workmen in the employ of Babcock & Wilcox Co., contractors for the manifolds and penstocks, and John W. Hall, resident engineer for Hugh L. Cooper & Co., consulting engineers for the project. Two other engineers, one on the B. & W. staff, and the other on the Electro Metallurgical staff, who were also inspecting the test, suffered minor injuries.

Mr. Hall, 49, had been associated with Hugh L. Cooper, Inc., at Keokuk, Iowa, Muscle Shoals, the Dnieprostroy plant in Russia, and more recently on the present job.

Power Survey

Results of the Federal Power Commission's survey of electric plants and rates will be presented in a series of reports, the first to be made shortly after the first of the year. Reports on that study go to the President. Returns from the field on the rate survey are proving difficult to interpret, but nevertheless the first report on this survey is expected to be ready for Congress.

PERSONALS

Harry P. Charlesworth has been elected chairman of the board of the Engineering Foundation, to fill the unexpired portion of terms ending Feb. 21, 1935. He is assistant chief engineer of A. T. & T. D. Robert Yarnall, of Yarnall-Waring Co., Philadelphia, Pa., has been elected first vice-chairman. Edward R. Fish, chief engineer of the boiler division, Hartford Steam Boiler Inspection & Insurance Co., has been elected second vice-chairman.

Ward Harrison, director of engineering of the incandescent lamp department, General Electric Co., at Nela Park, Cleveland, Ohio, predicted a 50 to 100 per cent increase in the generating capacity of the nation's power plants to provide light adequate for seeing, in a recent test before the senior class of Stevens Institute of Technology.

M. A. Buettell, formerly with the Dodge Mfg. Corp., has joined Ideal Commutator Dresser Co., Sycamore, Ill., as electrical engineer.

Harold S. Broadbent, formerly manager of the Commercial Engineering Department, has been appointed assistant to the vice-president, Westinghouse Lamp Co. He has been with the company for the past 13 years.

L. M. Klinedinst has been elected to the board and made vice-president in charge of sales of Timken Roller Bearing Co., Canton, Ohio, to succeed Judd W. Spray.

Robert J. Working has been appointed district sales manager in Cincinnati for Republic Steel Corp., Youngstown, Ohio. He succeeds W. A. Peck.

George Furbush has been appointed superintendent of stations of Central Maine Power Co., with headquarters at Augusta, Me. Mr. Furbush entered the company's service in 1902 as a station operator. Eight years later he became chief operator, and in 1911 was transferred to the department of maintenance and inspection.

Lloyd R. Stowe, formerly manager of the stoker department of Lacledе-Christy Co., and later in a similar capacity with Johnson & Jennings, of Cleveland, has recently joined Combustion Engineering Co., Inc., 200 Madison Ave., New York, N. Y., as district manager of the St. Louis territory.

Edwin Smiley has been appointed eastern district manager of Cyrus Wm. Rice & Co., Inc., with headquarters in the Commercial Trust Bldg., Philadelphia, Pa.

Charles E. Stuart, president and treasurer of Tyson Roller Bearing Corp., Massillon, Ohio, resigned Nov. 1. He will remain on the board of directors. Russell E. Colgate, formerly chairman of the board, has been elected president and treasurer. Ralph H. Maxson is executive vice-president in charge of operations, George C. McMullen vice-president in charge of sales, George Neupower secretary, and E. R. Earnest assistant treasurer and purchasing agent.

Whitley B. Moore has been appointed general manager of the industrial division, Timken Roller Bearing Co., Canton, Ohio. He has been with the company since the end of the World War, recently as sales manager.

John L. Young, until recently district general manager in charge of the Pittsburgh office, has been made assistant general manager of the industrial division and will move to Canton. He has been with the company since 1921. Harry D. Robb, with the company since 1925, succeeds Mr. Young. Harry H. Wood, with the company since 1929, has been transferred to Pittsburgh and appointed manager of the Rolling Mill Division.

Earl V. Snyder has been appointed district manager for New York State, except the New York City area, for L. H. Gilmer Co., Tacony, Philadelphia, Pa. He was formerly connected with American Engineering Co., Babcock & Wilcox, and International Motor Co.

J. P. H. deWindt, manager of the boiler and machinery department of the National Bureau, Royal & Eagle Indemnity Cos., 150 William St., New York, N. Y., recently spoke on "Machinery Direct Damage Insurance" as the second in the current series of lectures on Boiler and Machinery Insurance. H. W. Sanford discussed "High-Pressure Boilers—Direct Drainage," as the third lecture. Brokers and producers in the metropolitan area have enrolled for the series, which began Oct. 25. The lectures are being printed and copies will be supplied to anyone requesting them from the production department of either company.

OBITUARIES

Edwin H. Ludeman, 61, formerly in charge of the New York office of the Skinner Engine Co., Erie, Pa., died in New York recently.

Henry F. G. Wulf, president of the Monarch Cement Co., Humboldt, Kans., died Oct. 19 there.

Walter B. Devereux, 81, who installed one of the first American hydro-electric plants in Colorado, and the first electric hoist ever put in a mine, died in San Mateo, Calif., Nov. 19.

John F. Kelly, managing director of the Association of Iron & Steel Electrical Engineers, died in Pitsburgh, Pa., Nov. 19. For many years Mr. Kelly was secretary of the Association. When it was decided to publish "Iron and Steel Engineer" as the official organ, he became editor. Later he was also made managing director of the association. He was an able and enthusiastic leader, and under his direction the Association has grown to a position of outstanding influence in the iron and steel industry.

Kenneth Moller, 50, formerly a vice-president of Lockwood, Greene & Co., Boston, and for many years actively identified with the engineering problems of the textile industry, died at his home in Milton, Mass., Nov. 10, after a long illness. He was educated at Harvard and Massachusetts Institute of Technology, and in his early career was designer and engineer for the Fuel Oil Engine Co., Providence, R. I. Later he became general superintendent of Jenckes Spinning Co., Pawtucket, R. I., and then took up engineering and administrative work, becoming manager at Boston for Lockwood, Greene, whom he left about 1925.

BUSINESS NOTES

Oster-Williams, Cleveland, Ohio, has opened an office and display room at 292 Lafayette St., New York, N. Y., in charge of H. B. Van Osten as district manager.

Machinery and Welder Corp., 312-314 N. Sheldon St., Chicago, Ill., has opened a branch at 2118 W. National Ave., Milwaukee, in charge of Roy C. Kendall. The company is also expanding its transmission department, which has been placed in charge of F. E. Dunlap.

Motorstoker Corp., 290 Hudson St., New York, N. Y., has made the following additions and changes in its organization: Directors now include Walter Barnum, president, Daniel M. Armstead, Spruille Braden, Henry M. Brooks, William T. Gardiner, Edward L. Green, Dale M. Parker, Geo. H. Townsend. Willard G. Triest has joined the organization as executive vice-president, H. J. Wilson as vice-president and general manager, Col. James H. Hayes as counsel, Phillip Clover as general sales manager, H. L. Siegmund, as general manager of field engineering and service, C. B. Graves as assistant general sales manager.

Harnischfeger Corp., Milwaukee, Wis., has presented the Museum of Science and Industry of Chicago with complete equipment, including material-handling hoists for a permanent exhibit of industrial welding.

B. E. Vinson Co., Inc., Hunt Bldg., Tulsa, Okla., has been appointed sales representative for Edward Valve & Mfg. Co., East Chicago, Ind., in the Tulsa district.

Ridge Tool Co., Elyria, Ohio, is doubling the size of its plant as the result of increasing demand for the company's line of pipe tools.

Modern Coal Burner Co., a subsidiary of Peabody Coal Co., has relinquished its automatic stoker business, and Link-Belt Co., Chicago, Ill., has acquired manufacturing and sales right to the Modern coal burner.

Consolidated Gas Co. of New York, parent company of the largest group of gas and electric operating utilities in the world, celebrated its fiftieth birthday Nov. 10. Oldest of the member companies is the New York Gas Light Co., which was the first gas company in the city and the second in the country. It was organized in 1823.

Mundet Cork Corp., 450 Seventh Ave., New York, N. Y., has recently changed addresses of the following branch offices: Cincinnati, Ohio., 427 West 4th St.; Detroit, Mich., 335 West Jefferson St.; Memphis, Tenn., Medical Arts Bldg.; Philadelphia, Pa., 2228 Arch St.

Bailey-Burruss Mfg. Co., 1116 Murphy Ave., Atlanta, Ga., has been purchased by Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill., and will be consolidated with Link-Belt Atlanta sales office as the Atlanta plant. Combined operations will be headed by I. H. Barbee, who is being transferred from the Philadelphia plant.

Parry Engrg. Co., 154 Nassau St., New York, N. Y., has been appointed New York agent for Cyrus Wm. Rice & Co., Inc., Pittsburgh, Pa. (water purification engineers).

L. H. Gilmer Co., Tacony, Philadelphia, Pa., is increasing its facilities to meet increasing demand for V-belts and cable cord belts.

International Nickel Co., Inc., 67 Wall St., New York, N. Y., has moved the Detroit district office of its development and research department into General Motors Bldg.

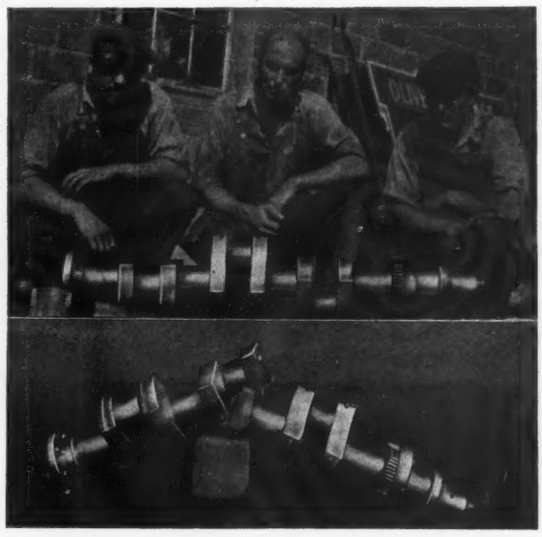
B. C. Electric Railway Co. has completed the work of replacing one-half mile of flume in its water conduit from Barriere dam in the Kamloops district. The new flume is box-shaped and of wood 5 ft. 4 in. deep by 6 ft. wide, and will be covered to avoid freezing. It replaces wood stave pipe.

Premier Mine, near Stewart, B. C., famous Portland Canal property, recently suffered the loss of its powerhouse, which burnt to the ground at a loss estimated at about $500,000. No one was injured, fire being caused by the backfiring of one of the engines. Some power will be available from gas engines at the mine workings. The Pelton wheel at the power-house was saved from the fire. Rebuilding has already been begun.

Bohn Aluminum & Brass Corp. has developed a new method of cylinder-head design for automotive engines, which eliminates the trial and error method of determining combustion chamber shape and dimensions, and is intended to provide maximum combustion efficiency for any given engine. The invention, the result of over five years of experimetal work by chief engineer David E. Anderson, actually determines the shape of the chamber, location of spark plug and other details of the cylinder head.

Kelvinator Corp., Detroit, Mich., has opened, at its Plymouth Road plant, a new "hot room" for checking refrigerator, water-cooler and air-conditioning apparatus performance. The room, 35x 17 ft., has d.c. current, water and gage positions to accommodate many units. It is heated by air forced into it through ducts leading from a fin coil. The laboratory can maintain desired temperatures without a variation of more than one degree plus or minus. Normally, it is held at 110 deg. The entire laboratory, including the concrete slab floor, is mounted on steel springs to minimize vibration. The outside wall is of cinder block 8 in. thick lined with celotex-lined air space 6 in. thick, and within that a 1-in. jacket of acoustical tile. Thus, passage of both heat and noise is curtailed, and operating noises in units under test are easily detectable.

CRANKSHAFT WELD SAVES $475



This broken diesel crankshaft, belonging to a 45-hp., 3-cyl. engine, weighed about 350 lb. Oliver's Garage, New Brunswick, S. D., repaired it for $75, instead of $550 for a new shaft. The broken parts were blocked up in a lathe, the broken section veed out with a cutting torch on one side, tack-welded, then veed out on the other side. Welding was done with a P & H-Hansen welder and the shaft out of the lathe, building up a little at a time. It was then returned to the lathe and straightened by a press to within 0.030 in. of true. All main journals were ground 0.050 in. undersize, the bearings rebabbitted and lined up

STRAWS

Pointing the way business winds blow

Willacy County Water Control & Improvement District No. 1, Raymondville, Tex., C. S. Clark, clerk, has plans nearing completion for 75,000-acre irrigation and water supply project, plus ultimate improvement of 130,000 acres, in parts of Willacy and Hidalgo Counties, about 20 miles from the Rio Grande River, which will be used as source of supply. Includes construction of a central generating plant to be used for power supply for 12 electric-operated pumping plants.

Lyles Ford Tri-County Authority, Union, S. C., has filed an application for a preliminary permit for a hydro-electric project on Broad, Tiger and Monroe rivers. 27,000 hp. is to be installed at Lyles Ford and 27,800 hp. at Whitmire, where water from the Tiger and Monroe rivers will be utilized.

Bountiful, Utah, plans to buy a $156,000 municipal diesel plant. Bonds will be issued shortly.

Rochester, Minn., soon takes bids for extensions and improvements in municipal electric light and power plant, including new 1-story boiler house, 54x78 ft. Cost about $95,000, with equipment. Fund has been arranged. Schuett-Meier Co., 490 North Snelling Ave., St. Paul, Minn., is engineer. Preliminary plans are under advisement for further expansion in power plant and facilities, to be carried out over a 24-month period, at cost estimated close to $1,000,000. This will include a new 1,000-hp. turbine with accessories, new boilers, etc.

Pigeon River Lumber Co. has applied for rights on Pigeon River, Cook County, Minn., and in the Province of Ontario, where it proposes to install 40,000 hp. Hearing Jan. 15.

Board of Public Works, Seattle, Wash., has awarded general contract to Rumsey & Co., Airport Way, city, for new power house, transformer and switching platform, and other auxiliary construction for Diablo power plant, to be used for municipal service, at price of $339,010. Generating and other equipment will be purchased under other contracts.

Decatur, Ala., has plans maturing for new municipal electric light and power plant, and expects to begin work by first of year. Fund of $350,000 is being arranged through Federal aid. James A. Nelson, mayor, is active in project.

North American Distilleries, Inc., Detroit, Mich., J. B. Sevald, Buhl Bldg., city, treasurer, recently chartered with capital of $1,325,000, plans a steam power plant at proposed new distillery on the St. Clair River, St. Clair, Mich. A water-pumping plant will also be installed. Initial plant, comprising several operating units, is reported to cost over $300,000.

Greenwood County, S. C., has received a Federal Power Commission license for a municipal power project at the Buzzard's Roost site on Saluda River. The revision project provides for construction of an earth dam across the river about nine miles above Lexington Power Co.'s Saluda reservoir, creating a power head of 60 ft. Power plant would include three 5,000-kw. units. PWA has provided $2,767,000, 30 per cent of it a Federal grant.

Newport News Shipbuilding & Drydock Co., Newport News, Va., has been awarded a $467,930 order for a hydraulic turbine for Norris Dam. A turbine for Wheeler dam, also a part of the TVA project, will be built by Southwark Corp., Philadelphia, for $339,400.

Johns-Manville has recently formed a subsidiary, Johns-Manville Credit Corp., through co-operation of the Federal Government, which will finance industrial and commercial repair and modernization work at 5 per cent. Amounts up to $2,000 may be obtained, to be paid back in from one to three years.

BUILDER UPPER

(Continued from page 663)

stainless and carbon steels. Costs ran between 5 and 50 per cent of replacement, with equivalent wear.

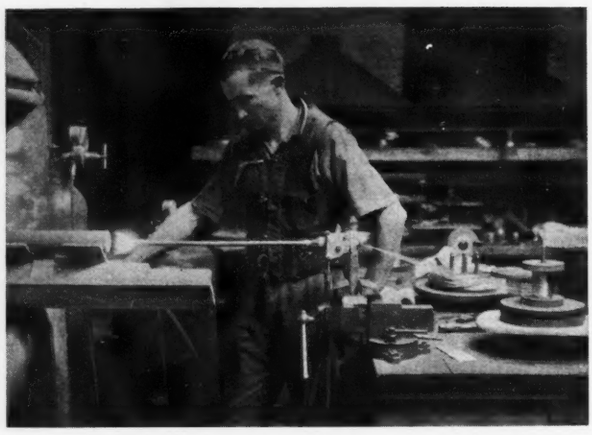
Tanks in which corrosion difficulties were encountered were sandblasted, then coated with an 0.010-in. coat of aluminum (1 lb. aluminum per 6 sq.ft.) at a cost of 15 to 50 cents per sq.ft., depending on difficulties of setup. With $\frac{1}{8}$-in. wire, 6 lb. could be applied per hr., covering 36 ft. and giving far more lasting results than the paint formerly used. Combustion heads for engines are also being aluminum coated to resist heat, increase compression, eliminate carbon deposits. Coatings run 0.005 to 0.010 in. thick, or in case of compression increase, as thick as required.

This brings up an interesting new use for the process, that of aiding equipment to resist deterioration under high temperatures. It is being used on grate bars, boiler baffles and tubes, gas burners, soot blowers, superheaters, etc. and has successfully prevented scaling and increased durability. After spraying, three dips or brush coats of potassium silicate are applied then the piece is heat-treated to 1400 deg. for 5 min., then raised to 1900 deg. and allowed to soak, the time depending on the piece. This produces a deep ferro-aluminum alloy with an aluminum oxide surface. The dried potassium silicate brushes off.

A 16-in. gas engine piston was built up to fit a rebored cylinder as an experiment. Cold-rolled steel was sprayed on the ring groove and end sections, duralumin on the center skirt to reduce spraying cost and time. (Dural has three times the volume of steel, yet can be sprayed at the same rate.) Sides of the ring grooves were also sprayed back to size. The job took 22 lb. of steel, 6 lb. of dural and $4\frac{1}{2}$ hr. to increase diameter $\frac{1}{32}$ in.

The only possible way to determine whether or not metal spraying will solve your problem is to try it. When intelligently applied, spray coating failures are surprisingly few. Material for this article has been taken from a number of sources, principally Metals Coating Co. of America, Metal Spray Co., Metallizing Co. of America, Inc., Air Reduction Sales Co., several public utility plants, and published data. The final draft has been read by R. L. Binder, president, Metals Coating Co. of America, R. A. Axline, eastern representative, Metallizing Co. of America, and E. V. David, Applied Engrg. Dept., Air Reduction Sales Co.

Rotating extension nozzle coating pipe interior with molten copper. Several wires are being fed simultaneously to get proper composition



San Carlos Project of Federal Government, Coolidge, Ariz., C. H. Southworth, district engineer, has authorized construction of a 2,500-hp. diesel plant to be used for standby service for the electrical system of the development, which will secure power from Coolidge dam. Diesel plant will consist of two or three units, with oil fuel for initial operation and possible change to natural gas in future. Station designed for installation of additional prime movers later, estimated to cost $250,000 total.

Wapakoneta, Ohio, will soon have plans completed for new municipal electric light and power plant, for which a bond issue of $160,000 was approved. Financing through Federal aid. Municipality has been operating its own electrical distribution system for some time.

Brazos River Conservation and Reclamation District, Breckenridge, Tex., care of State Board of Water Engineers, Austin, Tex., recently organized with authority of the State Legislature, has preliminary plans in progress for initial development. There will be a series of 12 dams at different points of the Brazos River and tributaries, seven to be used for hydro-electric power. The latter will include a plant at Cordova Bend of 11,000 kw.; at Breckenridge, 3,600 kw.; at Possum Kingdom, 13,000 kw.; Little Kreechi, 6,000 kw.; Seymour, 1,500 kw.; Inspiration Point, 11,000 kw.; and Bee Mountain, 16,000 kw.; totaling about 62,100 kw. Dams for water storage are scheduled at Bosque, Little River Belton, Lampassas, Belton and Georgetown. Project is estimated to cost $50,000,000, and financing is proposed through Federal aid.

Morris, Minn., is considering plans for financing without Federal aid in sum of $188,000 for construction of new municipal electric light and power plant, for which plans have been drawn by Burlingame & Hitchcock, Sexton Bldg., Minneapolis, Minn., consulting engineers. Diesels as prime movers. List of equipment to be installed has been arranged.

Green Brier Distillery and Hobbs Distillery, Chicago, Ill., recently organized by local interests as affiliated organizations, care of Paul Gerhardt, 64 West Randolph St., Chicago, architect, plan construction of power plants at proposed new distilleries at Bardstown, Ky., where sites have been secured. Entire project will cost approximately $500,000.

Miami Beach, Fla., is planning construction of new municipal electric and power plant, and has authorized estimates of cost and preliminary plans. Engineer will be selected at once. Claude A. Renshaw, city manager, in charge.

Waterworks Dept., Cincinnati, Ohio, Albert Hibbs, supt., is considering an expansion and improvement program to be carried out over a period of months, with ultimate cost estimated at $2,500,000. Initial work will include purchase and installation of new electric-operated pumping equipment to cost $75,000, with new addition to pumping station at Western Hills to cost about $170,000. Extensions will be made in municipal filtration plant. Pipe lines will be installed.

Construction Service, Veterans' Administration, Washington, D. C., receives bids until Jan. 3, 1935, for new buildings and utilities at institution at Togus, Me., the latter including complete refrigerating and ice-making plant, electrical equipment and installation, outside electrical distribution and steam distribution systems, water supply system, etc.

Rocky Mountain Power Co., a subsidiary of the Montana Power Co., Butte, Mont., has been denied an indefinite extension of time by Federal Power Commission for completion of Flathead hydro-electric power project on Flathead River, near Flathead Lake, Mont., on which work has been pending for a number of months. The original license granted company called for completion of project in May, 1934, at estimated cost of $8,000,000. Early action is expected in connection with project, which calls for construction of a dam about 150 ft. high across Flathead River, with hydro-electric generating station of 150,000-hp. rating, divided into three 50,000-hp. units.

State College of Washington, Pullman, Wash., is asking bids until Jan. 1, 1935, for mechanical equipment for new power plant. Includes boilers, coal storage and conveying, feedwater treating, feedwater pumps, engine-driven forced- and induced-draft fans and ducts, along with necessary piping. PWA allotment. H. H. Langdon, engineer, State College of Wash., engineer in charge. One copy plans, specifications and advertisement on file with McGraw-Hill Publishing Co., 330 West 42nd St., New York, N. Y.

Tulare, Porterville, Hanford and Lindsay, Calif., have voted to organize a utilities district for furnishing natural gas for commercial service, as well as in Exeter, Visalia and Lemoore, other communities in the valley. Cost $950,000. Will be known as "Central Counties Municipal Utility District." Mayor Charles Burr, Lindsay, is active in project.

State Building Commission, Capitol Bldg., Jefferson City, Mo., has authorized plans for a new power plant at State School for Feeble-Minded, Marshall, Mo., and plans call for bids in near future. It is estimated to cost close to $150,000. Charles A. Haskins, Finance Bldg., Kansas City, Mo., consulting engineer; L . R. Bowen, 315 North Seventh St., St. Louis, Mo., supervising engineer.

Jackson Brewing Co., New Orleans, La., J. F. Boreland, general manager, plans construction of boiler plant at proposed new brewery at Shreveport, La. Brewing plant will consist of several units, with initial capacity of about 8,500 barrels per month, and will cost over $350,000.

Board of District Commissioners, District Bldg., Washington, D. C., plans construction of a large central power plant in connection with proposed new sewage disposal works, for which Federal aid of $8,000,000 is being arranged. Generating station and equipment is estimated to cost $1,200,000. Metcalf & Eddy, Statler Bldg., Boston, Mass., consulting engineers.

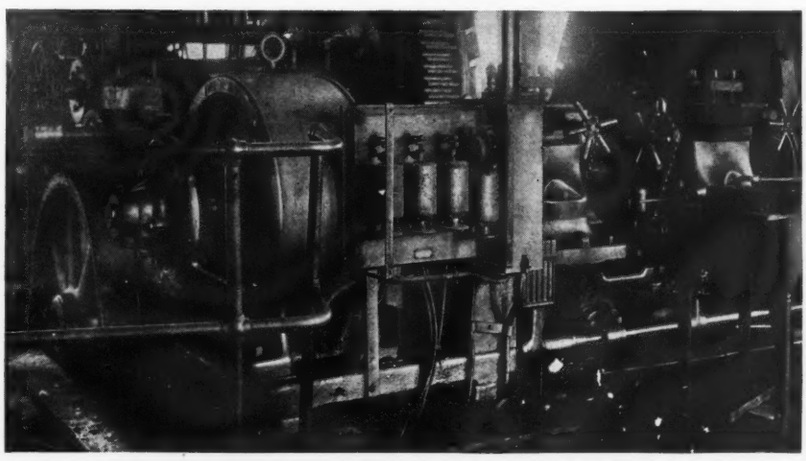
North Jackson (Ohio) Supply Co. has installed a 60-hp. 1,200-r.p.m., 4-cycle Fairbanks-Morse diesel. Fairbanks-Morse has sold Beam Milling Co., Hemlock, N. Y., a 60-hp. engine, and one engine to Sperry Garard Milling Co., Rochester, N. Y. This company was also low bidder on the engines at Fairfax, Minn.

Nordness (Iowa) Creamery Co. is planning a private diesel plant.

Dawson Creek Milling Co., Ltd., has completed plans for a 65-barrel flour mill at Dawson Creek, B. C. Diesels will supply the power.

New Westminster, B. C., is investigating the possibility of a city-owned power plant.

Red Bluff Dam, on the Pecos River, about 50 miles north of Pecos, Tex., is under construction following approval of the $1,330,000 main contract by PWA. The project includes an earth-fill dam, hydro-electric power plant and transmission system estimated to cost $2,600,000.



STARTER IN ACTIVE SERVICE FOR 26 YEARS

This control, the first of its type ever installed, is in active service in the Montgomery, Ala., shops of Western Railway of Alabama. Installed in July, 1908, to control a 90-in. lathe driven by a 25/40-hp., 220-volt motor, this Westinghouse starter has operated continuously, the only maintenance being replacement of the magnet coils once during the past 26 years.

NEW BULLETINS

Pipe and Boiler Gaskets — Flexitallic Gasket Co., 8th and Bailey Sts., Camden, N. J. Exceptional 10-page, flat-opening catalog, "22 Years of Increasing Use in Industry," shows construction, typical application, specifications.

Welding Equipment — Lincoln Electric Co., Coit Road and Kirby Ave., Cleveland, Ohio. Bulletin No. 30, General Specifications for A.C. Motor-Driven Types SA300, SA400 and SA600 Welders. Also Bulletin 304 on Engine-Driven Type SA300.

Precision Balances — Roller-Smith Co., 233 Broadway, New York, N. Y. Eight-page Catalog No. 240 illustrates and describes precision balances for weighing and determination of surface tension, specific gravity, etc., and includes attachments and accessories.

Water Columns and Gages — Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa. 16-page Bulletin WG-1803 covers improved line of Yarway floatless Hi-Lo alarm water columns and vertical and Secure-inclined water level gages for boilers. Working pressures to 1,500 lb. Bulletin includes operating features, prices, dimensions, weights, typical installations.

Water Meters — Worthington-Gamon Meter Co., Harrison, N. J. Five new bulletins: M-975-B12 on Frost-Proof Disc Meter with open gear train; M-975-B13 on Watch Dog Disc Meter, frost-proof model with inclosed gear train; M-975-B14, Watch Dog Disc Meter, split-case model with open gear train; M-975-B15, Watch Dog Disc Meter, split-case model with inclosed gear train; M-975-B16, Model R Disc Meter.

Conveyor—Stephens-Adamson Mfg. Co., Aurora, Ill. 16-page Redler Conveyor Catalog describing this inclosed "continuous flow" unit for handling bulk material. Consists of inclosed steel trough, through which is pulled a light skeleton conveying element that causes the material to flow in a solid, tranquil column. Conveyor will feed itself a full load from bins or hoppers, and can be discharged anywhere by opening slide gates.

Abrasive Wheels—Bakelite Corp., River Road, Bound Brook, N. J. 24-page booklet, "High-Speed Abrasive Wheels Bonded With Bakelite Resinoid."

Nickel Applications — International Nickel Co., Inc., 67 Wall St., New York, N. Y. Data booklet on applications of Monel metal, nickel, and nickel-clad steel to industrial processing equipment, physical and mechanical properties, instructions on selection of suitable welding rod, details on fabrication.

Electrical Steam Generator—E. Leonard & Sons, Ltd., London, Canada. 8-page Bulletin 600 on Penzold electric steam generator.

Pipe Fittings—Hays Mfg. Co., 12th & Liberty Sts., Erie, Pa. 24-page Catalog Section 3 illustrates and describes Hays double-seal fittings for use on joints which must not loosen through vibration, torsion, deflection, freezing or vacuum.

Motoreducer — The Falk Corp., Milwaukee, Wis. 36-page Bulletin No. 272 on Motoreducers includes data and rating tables on 2-speed units and amplifies and correlates previous published information.

Hydraulic Packing—Chicago Belting Co., 113-125 North Green St., Chicago, Ill. 4-page folder describing engineering service on hydraulic packing.

Power Pumps — American Steam Pump Co., Battle Creek, Mich. Two bulletins, 4-page on Redi-Oiled Piston Packed Duplex Power Pumps, and 4-page on Type MUE single-stage, end-suction centrifugal motor-unit pumps.

Worthington. Worthington Pump & Machinery Corp., Harrison, N. J. Two new bulletins. 6-page W-310-B4 on Centrifugal Pumps, Types C, CA and CB. 8-page S-500-B6C on Vertical Four-Cycle Direct-Injection Diesels, Types B, C, D and E.

General Electric, General Electric Co., Schenectady, N. Y. New bulletins include 4-page GEA-1791A on Service-Drop Cable, Tamperproof Types, 4-page GEA-1953 on Magnet Wire and Coils; 10-page GEA-1979 on G-E Reduced-Voltage Starters of the Auto-Transformer Type for Squirrel-Cage Induction Motors, 2-page GEA-1913 on G-E Pyrotip Electric Burner for Cutting and Welding, 8-page GEA-1909 for Automatic Reclosing of Oil Circuit Breakers, 8-page GEA-1898 on I-20 Metering for Meeting Diverse Installation Practices.

NEW PLANT CONSTRUCTION

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Calif., Sacramento — Sacramento Municipal Utility Dist. voted $12,000,000 bonds to construct electric distribution system and steam generating plant. Construction of power plant estimated $3,000,000. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

Calif., South San Francisco—City making surveys for complete unit diesel electric power plant. Preliminary estimate $350,000.

Calif., Tracy—City plans survey for diesel energy for operation of pumps at municipal water plant and lighting plant.

Fla., Jacksonville—Municipality plans electric power plant addition. $430,000. Taylor Eng. Co., Jacksonville, engrs.

Ind., Waterloo—City Council, F. S. George, pres. Council, plans municipal light plant. $22,000. Francis Eng. Co., Saginaw, Mich., engrs.

Ia., Iowa City—P.W.A. rescinded $917,000 loan and grant for power plant and distribution system, for City, upon applicant's request.

Ia., Macodonia—Election Dec. 4 on granting franchise to Iowa-Nebraska Light & Power Co., to construct, maintain and operate electric light and power system.

Ia., Sheldon—Election Nov. 27 on question of establishing, maintaining, operating municipal light and power plant and to issue $240,000 in revenue bonds to defray the cost thereof. H. L. Cory, 503 Baum Bldg., Omaha, Neb., consult. engr.

Ky., Burkesville—Cumberland Co. made application to State Public Service Comn. for permission to construct municipal power plant.

Ky., Fort Thomas—Cincinnati, Newport & Covington Ry. Co., Covington, plans power substation. $30,000.

Mich., Morenci—City defeated bonds for construction municipal electric light system. $146,000.

Mich., South Haven—City plans for power house extension, incl. 2,000 kw. turbines, boiler feed pump, steam piping and traveling screen at power house intake. Hamilton & Weaver, Grand Rapids, engrs.

Mo., LaPlata—City final plans completed for power plant and distribution system. $100,000. P.W.A. project. E. T. Archer & Co., 609 New England Bldg., Kansas City, engrs.

Neb., Columbus—Loup River Public Power Dist. making plans 2 electric power plants, 66 kv. and 110 kv. 175 mi. power transmission lines, steel towers 2 rein.-con. dams, 1,100 ft. long, 10 ft. high. Harza Mfg. Co., 205 West Wacker Dr., Chicago, Ill., engrs.

Neb., Omaha—Creighton University, Omaha, plans by L. A. Daly, Insurance Bldg., Omaha, power plant. To exceed $40,000.

N. Y., Canandaigua—City Council retained L. C. Reynolds, consult. engr., Geneva, to make survey for municipal light and power plant.

O., Dover—City plans electric power plant. $330,000. P.W.A. project. W. Hartline, Dover, engr.

O., Wapakoneta—Municipality, plans electric power generating plant. $160,000. Frayne Combs, engr.

Okla., Muskogee — City defeated bonds for construction power and light plant. $1,200,000.

Pa., Emaus—Borough defeated proposition to construct power plant. $265,000. Project abandoned.

Pa., New Castle—City plans election in January to vote on bond issue for construction of light and power plant. Est. $3,750,000. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs. G. H. Hoskins, City Hall, city engr.

Tenn., Memphis — City, voted $9,000,000 bonds to purchase existing electric power distributing system or to build competing facilities.

Tennessee — Tennessee Valley Authority, Knoxville, authorized construction Pickwick Dam on Tennessee River, forming lake 53 mi. long, near Pickwick Landing, dam will be 7,710 ft. long, incl. 2 earth dam sections, 600 ft. navigation lock, 110 ft. wide. $22,000,000. Provisions will be made for later power installation to consist of six units of 34,000 kw. cap. U. S. Engineers, Nashville, preparing plans.

Tenn., Knoxville — City authorized Burns & McDonnell Eng. Co., engrs., 107 West Linwood Blvd., Kansas City, Mo., to proceed with plans for light plant and distribution system. $3,000,000. T.V.A. will not purchase private utility.

Tex., Gatesville—City postponed election to vote on $60,000 bonds for proposed waterworks and light plant improvements. Montgomery & Ward, Wichita Falls, engr.

Tex., Morton—City, c/o H. Cox, mayor, indefinitely postponed taking bids for water system, incl. well supply, and electric light plant and distribution system. $23,000. H. N. Roberts, Lubbock, engr. P.W.A. project.

Tex., Houston — City, c/o Secretary, plans submitted to P.W.A. for municipal and harbor improvements, incl. refrigeration, cold storage and diesel power plant, also harbor improvements. $150,000. Garrett Eng. Co., 300 Houghes St., engrs.

Va., Lexington — Municipality, preliminary plans municipal electric power plant. To exceed $100,000.

Alta., Rimby — W. A. Saunders preparing plans and estimates for electric power scheme for Town.

B. C., Stewart — Premier Gold Mine Co., Stewart, plans rebuilding power house, completely destroyed by fire. Loss $200,000. Owners interested immediately in complete new equipment.

B. C., New Westminster—City plans to have consulting engineers make a survey of the power situation. At the present time the city buys its power in bulk from the British Columbia Power Corp. and distributes through its own mains.

Ont., Alexandria—Cheese Factory Patrons Assn., A. McGillis, chn. Com. of Committee, plans cold storage plant for agricultural products. $100,000.

Ont., Schrieber — E. J. Sheehan, Recve. of Town, plans municipal electric light plant. $75,000. Interested in prices of meters, transformers, wire, etc.

Ont., Toronto—Bids Jan. 8, by Bd. Control, supply and installation one 2,000,000 imp. gal. centrifugal sewage pump, motor and appurtenances.

Sask., North Battleford — Power Com. in market for 1,500 kw. turbo-generator, $35,000.

New Zealand, Wellington—Bids Jan. 29, by Director General Stores, Div. Posts & Telegraph Dpt., supplying 4,450 yd. cord instrument: 2,000 yd. cord switchboard; Feb. 19, by Secretary Public Works Supply & Tenders, outdoor steel work, incl. steel structure, disconnects and insulators, stacks and spares, copper tube and connectors, switchboard, fuse resistance combination for Arapum Scheme of Henderson; Mar. 5, seven 8,000 kva. transformers and spares.

Australia, Sidney—Bids Jan. 7, by City Engineer supplying complete automatic control equipment for 3 boilers at Bunnering Power Station***. **Brisbane**—Bids Jan. 25, by City Engineer, for 18,750 kw. turbo generators, and complete condensing plant, etc.

England, Liverpool — City Engineer, takes bids in December for Clarence Dock Power Station. $1,730,000 voted***E. D. Lyons, 34 Vaughan Bldg., Ilford, preparing plans power house, **Wolverhampton**, $530,000.

POWER
Established 1884
McGraw-Hill Publishing Company, Inc.
PHILIP W. SWAIN, *Editor*

WASTED DOLLARS

"ARE YOU INTERESTED IN PROFITS?" If you dare, ask this question of the industrialist who has been sweating for five years to hold together a skeleton organization, and meet payrolls.

HE WILL TELL YOU PLENTY: No stone has been left unturned. Costs have been cut to the bone. Every sales possibility has been explored. If anybody thinks he can run the business better these days he's welcome to the damn job.

WE TAKE OUR HATS OFF to this man. He has many talents and capacities which we power engineers admire. He is fighting a terrific battle to keep the old ship moving against head seas.

BUT LIKE ALL MEN WHO ARE BUSY with a thousand responsibilities, he overlooks some things—and some of the things he overlooks are important. Specifically, power.

WE MUST REPORT THE SIMPLE FACT, common knowledge of all power engineers, that American industry is wasting hundreds of millions annually because its top executives are too busy with other matters and too impressed by the intricacies of power engineering. Thus they fail to study the department with the largest percentage of waste—about 50 per cent on the average.

LET'S PUT THIS IN THE FORM of an engineer's statement to his executive: "Ours is an average industrial establishment. As such we are wasting 50 cents out of every dollar spent for the generation, transmission and application of our power services. Our present power-service expenditures—for coal, oil, purchased electricity, labor, supplies, maintenance and breakdown losses, etc.—are X dollars, as your own books will show.

"THIS CAN BE CUT IN HALF. I am prepared to show you just where and how the savings will be made and to give you the investment cost. Will you take a little time to figure the effect on the profits of your business for the next three years?

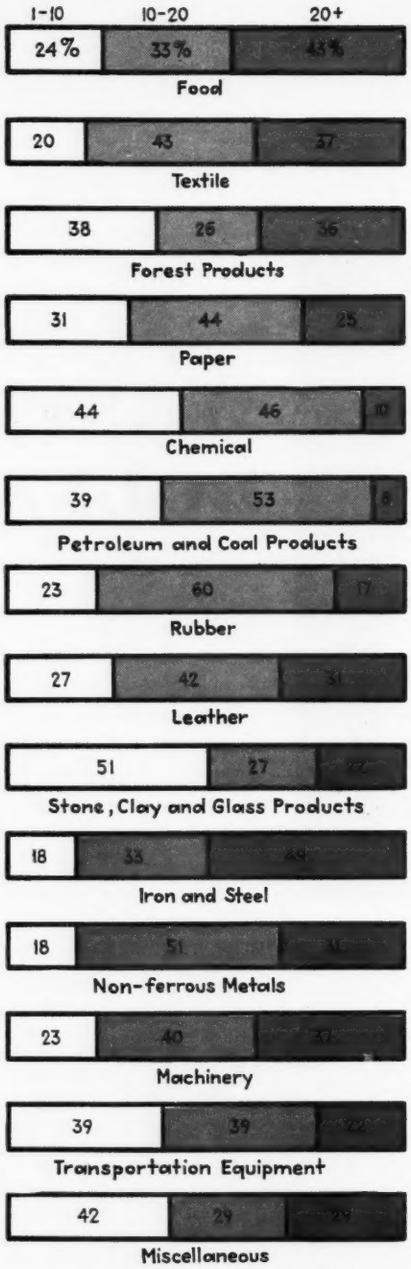
"FOR YEARS YOU HAVE CONSIDERED me competent to run your power plant. Are you willing to trust my experience and judgment in this matter? If not, will you select your own consulting engineers—some organization of unquestioned experience, ability and disinterestedness—to go over our power setup and tell you whether I am right or not? I'll stake my job on that!"

WE HAVE NECESSARILY PICTURED an average plant. In practice each must cut his cloth to fit his own suit. Yet the average means a lot to the industrial executive who must stand or fall on the field of business competition. To win he must be better than the average. The excessive power cost of the average plant is the measure of his competitive opportunity.

TO THE INDUSTRIAL EXECUTIVE we offer just this final word: "It is a fact that power services cost about 1½ billions of dollars a year—from 3 to 10 per cent of national manufacturing cost. It is a fact that your average competitor wastes half of the money he spends for power. It is a fact that *you* can stop that waste, as far as it exists in your own plant, any time you feel like it. Draw your own conclusions."

WHERE AND HOW CAN THOSE savings be made? Read the pages that follow:

OLD MAN OBSOLESCENCE



Age of surveyed power equipment divided by industries

LAST year the statement was made in these columns that 50 cents out of each power dollar is wasted. The fairness of this claim was questioned, so we gave a lot more thought to the matter, reviewed our own experiences, talked with engineers who had operated plants for years. Our final conclusion is that the statement is conservative, that we can stand by it without fear or embarrassment.

It may be pointed out that no one could prove it one way or the other without personally visiting and studying every industrial establishment covered by the U. S. Census of Manufactures, and that even then one could debate endlessly about how much waste is commercially preventable.

Quite true! This statement cannot be proved mathematically from available statistics. It is a rough estimate based on years of observation.

Those of us who constantly visit new and old plants, month after month, year after year, gradually get a composite picture which we can compare with the commercial ideal. And that picture—take it or leave it—is of a plant whose power operating costs could be cut approximately in half by shifting to today's best levels of equipment, hookup and operation.

To clarify the picture of the power dollar snipped in half, we should make clear exactly what we are talking about:

1. Central stations are *not* included.
2. The statement applies to industrial power plants.
3. Building and institutional plants may be included without appreciable change in the picture.
4. The statement covers all forms of power, the combined power-service plant for steam, electricity, mechanical power, hot and cold water, refrigeration, compressed air, heating and ventilation.
5. It includes not only generation, but transmission and application within the industrial establishment.
6. It does not consider any possibility of changing the existing rate schedules for purchased electricity, but does include savings that could be made by more intelligent use of existing rate schedules, or by shifting from purchased power to local generation or vice versa, or to some new allocation of the load between purchase and generation.
7. It considers not only what savings can be made with existing equipment and hookup but a possible shift to the best adapted equipment in the most suitable hookup.
8. The waste under consideration is the commercially preventable waste in operating dollars.

Since the round figure of 50 per cent preventable waste is an estimate, it would be unwise to attempt any fine breakdown into its constituent parts, but an imaginary example will show how the losses may easily exceed this amount. Steam pressure, let's say, is 150 lb. and 25 per cent of all steam is wasted to atmosphere. Raising the steam pressure to 400 lb. eliminates this loss. Better control of power and heat applications cuts steam production another 20 per cent.

New boilers installed for 400-lb. pressure are naturally provided with the latest firing equipment, furnaces, heat-recovery devices, controls and instruments. Boiler-room efficiency jumps from 60 per cent to 80 per cent.

Finally, clinkering limited the old boilers to expensive coals. The new equipment will handle coal costing three quarters as much on a heat-unit basis. Here's the final result:

$$\frac{75}{100} \times \frac{80}{100} \times \frac{60}{80} \times \frac{3}{4} = 0.34,$$

meaning a 66 per cent reduction in the coal bill, an extreme case, but not unheard of.

Big savings are possible in many other elements of power-service cost. You comb the old plant for wastes like you comb a dog for fleas.

Potential savings may be divided into two broad classes:

1. Those that can be made by an alert chief engineer without executive cooperation.

2. Those that demand whole-hearted cooperation.

Without any executive backing the good engineer can do (and does) a lot to build profits and dividends. He urges greater care in consumption of services. He plugs leaks of water, steam and air. He keeps an eye on power factor and maximum demand, applies some heavy thinking to rate schedules, spots leaky steam traps, puts maintenance on schedule. He shifts loads to avoid peaks and atmospheric exhaust.

He does all these things and much more, and then he strikes a stone wall. He'd like to buy a much cheaper coal locally available, but can't because it would clinker with his present firing equipment. He has jacked up his boiler-room efficiency a lot, but is still 10 points shy of what he should get because his men have to run the plant blindly, without necessary recording instruments, and dulled for thinking by too much sweating.

In spite of his best efforts, exhaust steam blows to atmosphere because engines and turbines are inefficient and steam pressures much too low.

The good engineer always goes ahead and completes his "class-one" job with or without executive cooperation. Then he's stuck unless the executive has a little imagination or the engineer enough sales ability to demonstrate the advantage of bigger and better junk piles (outside the plant—not inside).

The possible savings from modernization are often spectacular. Frequently $1,000 spent now will save $2,000 this year, $2,000 the next and so on. A man trained in a bank couldn't believe it, but every practical factory man knows it is true and why.

Insulation on a bare steam line is an outstanding example of an investment that returns considerably more than 200 per cent yearly. Instruments frequently top 100 per cent return. Many of the large investments, in engines, turbines, boilers and firing equipment will, under proper conditions (notably with higher pressures) net 30 to 50 per cent yearly.

Generally these days an engineer will not even try to pass a requisition for new equipment unless he is sure of at least 25 per cent return on the investment. At that he often gets prematurely gray trying to sell management the idea of operating at a profit.

Management needs a truer picture of what obsolete equipment is. Here is the test for your own plant. First decide how quickly new equipment must pay out to be worth your while. Let's say you pick three years. Then compare the operating cost of any piece of existing equipment with that of the best on today's market. If the savings will pay the first cost of the new in three years the old is obsolete.

Power has just completed a survey of 454 industrial power plants, chiefly to determine the age of the power-generating equipment and thus give an approximate idea of the present power situation in the matter of obsolescence. The job has taken months.

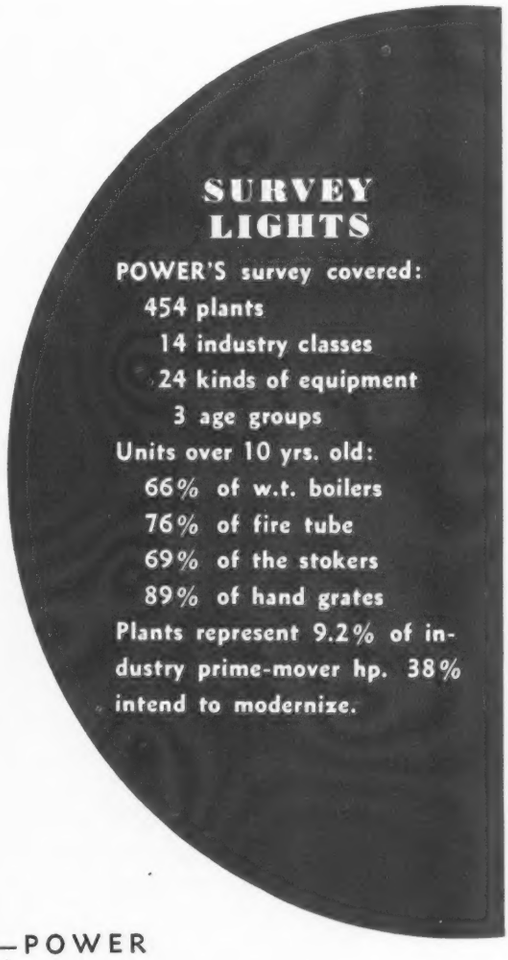
Plants were broken down into 14 major industry divisions. Equipment was reported in three age groups: 1 to 10 years, 11 to 20, over 20. The colored pie charts on the following pages tell the story, the percentages in the three age groups being represented by white, pale green and dark green, respectively.

You will find a lot of equipment over 20 years old, machines that were operating when the German army was marching on Paris, when today's college seniors were riding around in baby carriages. Shades of 1914!

And then remember that the plants surveyed are way above the national average both in size and quality. Beyond question the average plant has a much higher percentage of old (and largely obsolete) equipment.

The point, as indicated on page 703, is that every management which wishes to move away from cut-throat cost competition can do so, not by the dangerous expedient of raising prices or lowering quality, but safely and surely by cutting power costs. If history is any guide, the majority will not have sense enough to catch up.

In the following pages you will find specific suggestions regarding where and how these savings can be made.


SURVEY LIGHTS
POWER'S survey covered:
454 plants
14 industry classes
24 kinds of equipment
3 age groups
Units over 10 yrs. old:
66% of w.t. boilers
76% of fire tube
69% of the stokers
89% of hand grates
Plants represent 9.2% of industry prime-mover hp. 38% intend to modernize.

THE INGREDIENTS OF

CHEAP STEAM

THE output of a boiler room is so many thousand pounds of steam at a certain pressure and superheat, made from feed water at such and such temperature. To get it you pay a certain fuel bill, a certain labor bill. You pay so much for maintenance, supplies, supervision, fixed charges. The boiler-room problem is to keep the total of these costs, per unit of output, as low as possible.

Now the important thing to remember about a boiler room is that every piece of equipment ties in with every other—the parts cannot be considered independently. Since this article is intended for the attention of general industrial executives as well as power engineers, a brief picture of a typical modern boiler plant will not be out of place.

Coal (if that is the fuel) is received directly by rail or water, is mechanically handled to storage and/or to overhead bunkers or silos. From these it is delivered to stokers or pulverizers. From the latter, if used, the pulverized coal is fired directly or indirectly. Ash collected is delivered by gravity to cars, trucks, or conveying systems; the latter may be mechanical, hydraulic or pneumatic.

Forced and induced-draft fans speed up fuel burning—get more work out of the given investment in boilers and firing equipment. To handle the resulting high rate of combustion a large furnace is required. Since an efficient furnace is always a hot furnace, air- or water-cooling may be used to protect the brick work. Some of the waste heat in the flue gas is salvaged by economizers (which heat the feed water) or air pre-heaters (which warm the air supplied to the furnace).

Coal is weighed as fired. Instruments measure flow of steam and feed water, draft pressures, pressure and temperature of steam and feed water. Without these instruments, efficient operation would be impossible.

This up-to-date plant is equipped with soot blowers and automatic feed regulation. Feed water is chemically purified to avoid scale and corrosion, heated in closed or open heaters to as high a temperature as possible, "deaerated" to get out the dissolved oxygen that causes so much corrosion.

The average obsolete boiler plant operates at about 60 per cent efficiency (sometimes lower). It is not difficult to get a new plant that will average 80 per cent. The difference will cut the fuel bill 25 per cent, assuming that the same grade of fuel is burned. Very often the new equipment can handle a much cheaper fuel without clinkering or similar troubles. Here is a further saving, often amounting to 50 or 75 cents a ton of coal.

Bad water treatment means heat waste, excessive depreciation and high labor costs. Manual handling of fuel and ash wastes labor and lowers plant morale.

Never forget the matter of steam pressure when modernizing the boiler plant. A boiler designed for substantially higher pressure may not cost much more, and some day the extra pressure may be a gold mine for savings in the generation of by-product power. This point is discussed more fully in the article "Cheap Power," page 711.

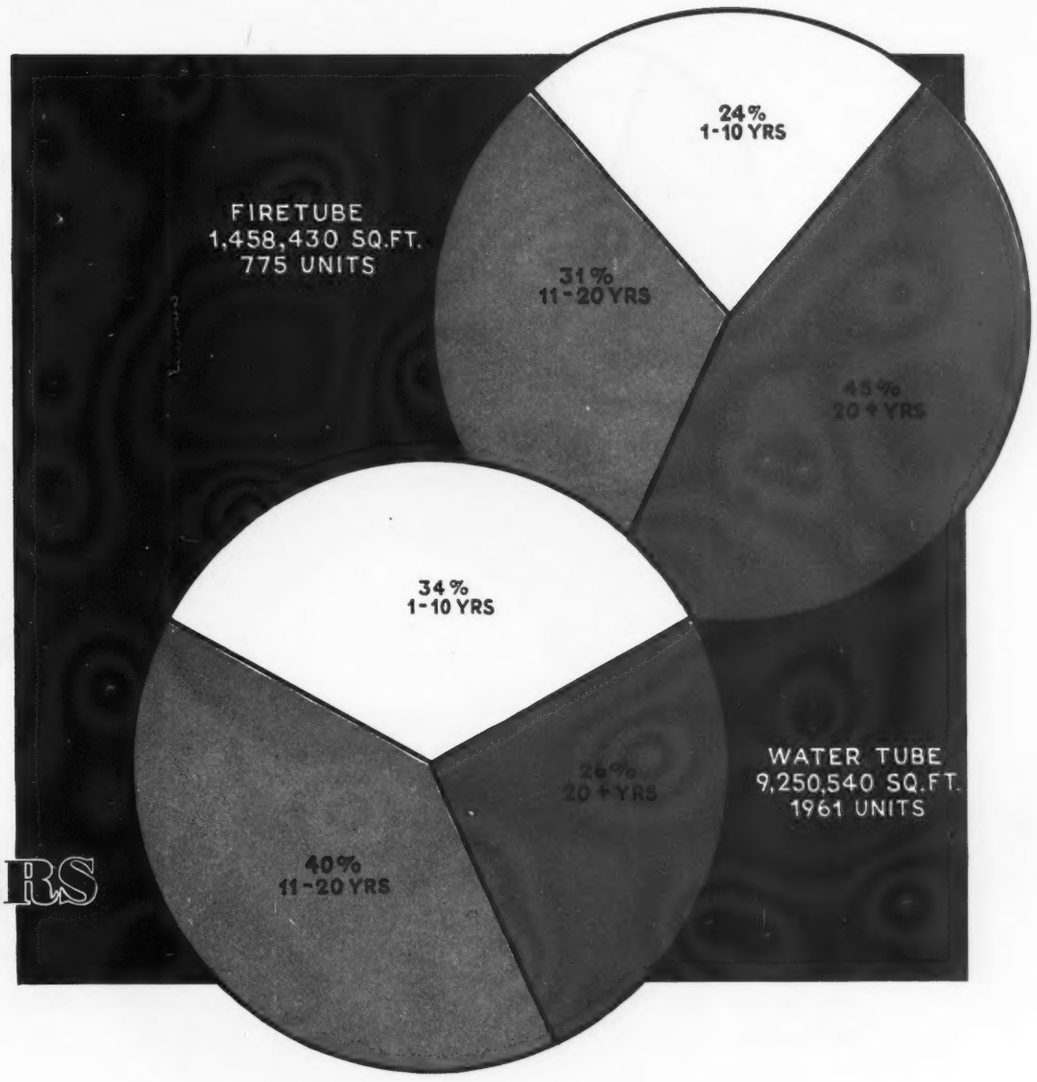
If we think, as we should, of low total steam cost, as well as low unit steam cost, we shall watch consumption. Stop the direct use of high-pressure steam where exhaust steam would do the work. Study engine-room hookups and units to reduce waste of exhaust to condenser or atmosphere.

13,329

EQUIPMENT ITEMS
were surveyed, including:

Water-tb. Boilers	1,961	Hand Stokers	114
Fire-tb. Boilers	775	Auto. Stokers	1,320
Hand-fired Grates	664	Pulverizers	187
Steam Engines	949	Oil Burners	521
Steam Turbines	600	Gas Burners	280
A. C. Generators	660	Superheaters	730
D. C. Generators	486	F. D. Fans	597
Air Preheaters	65	I. D. Fans	221
Cent. Feed Pumps	476	Economizers	176
Recip. Feed Pumps	844	Open Heaters	422
Chem. Softeners	131	Clos. Heaters	170
Zeol. Softeners	178	Water Wheels	202

BOILERS



PIE charts summarize ages of boilers in the 454 plants reported in *Power's* Equipment Survey. Percentages are based on heating surface rather than number. A numerical split would show a larger percentage of old units because the older boilers are in general, smaller.

In the diagrams, white indicates boilers 1-10 years old, pale green 11 to 20, dark green over 20. The same scheme is followed in all the other survey pie charts on succeeding pages. Percentages among the three age groups are allotted to boilers, prime movers and generators on a capacity basis, to all others on a numerical basis. Note the swing from fire-tube to water-tube boilers in recent years.

Age, as has been indicated, is not always proof of obsolescence. Yet a 20-yr.-old boiler, with 20-yr., old firing, is certainly obsolete unless used for standby only, because new units will give 10 to 15 points better efficiency and save their cost in three or four years.

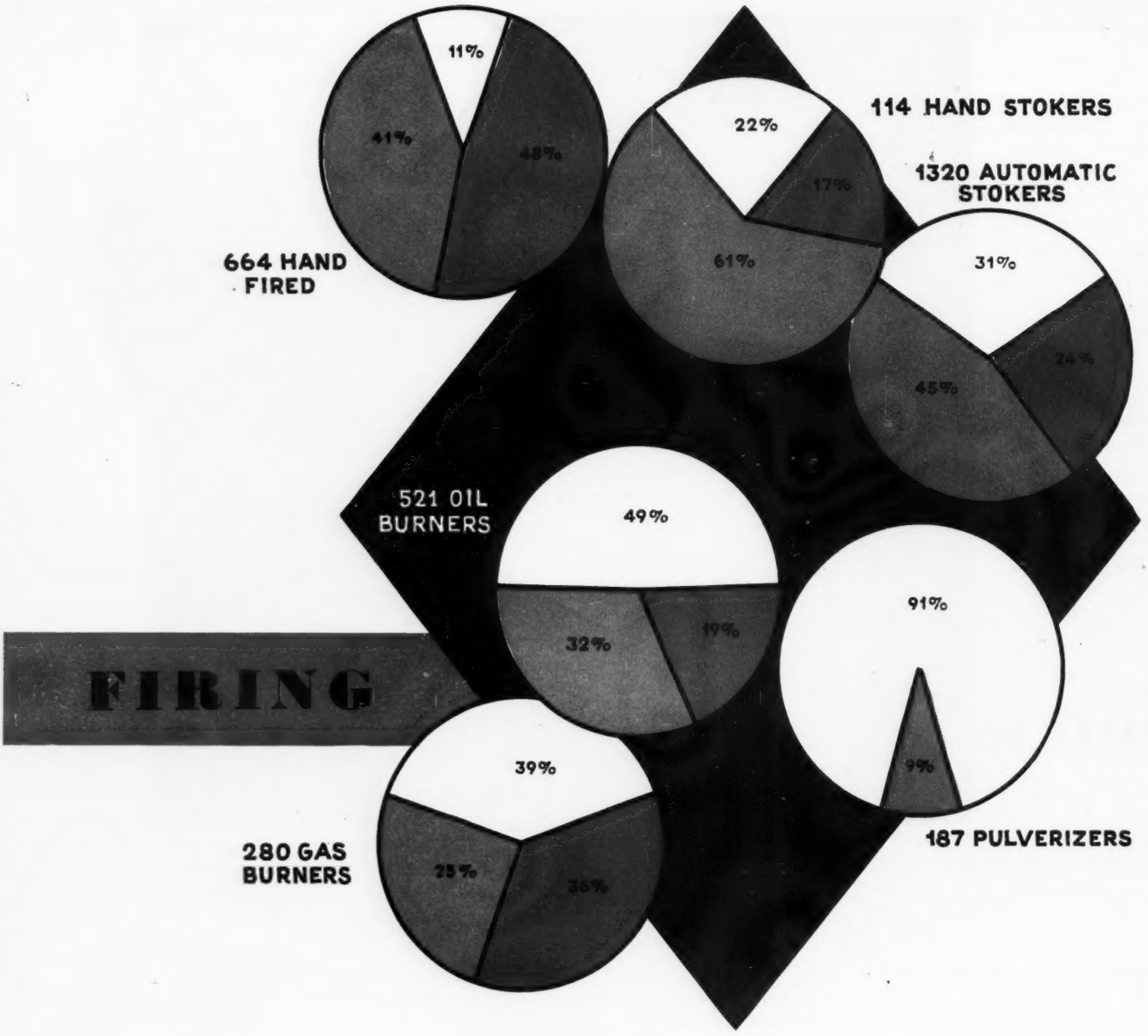
Younger boilers, in the 10-to-20-yr. class, may be obsolete, or they may merely require new firing equipment, higher settings and modern furnaces to compete reasonably well with units that are completely modern.

The survey does not cover furnaces, but their great importance should not be overlooked. The old idea was to set the boiler "close to the fire to absorb as much heat as possible." Today every engineer knows that the old idea is wrong; enough space must be left for complete combustion of the gases before they strike the relatively cool tubes.

A lot can be done with existing boilers by raising the settings, installing new firing equipment and protecting furnace walls by water or air cooling.

However, the large number of very old boilers now in operation is creating a real problem for the insurance companies. Every owner should consider the possibility that some of his old units may become uninsurable, or insurable only for some lower and dollar-wasting steam pressure.

Never start boiler-room modernization without rehashing the whole question of higher steam pressures. To do so may be a major business and engineering error. The reason will be more clear if you read the article on page 711.



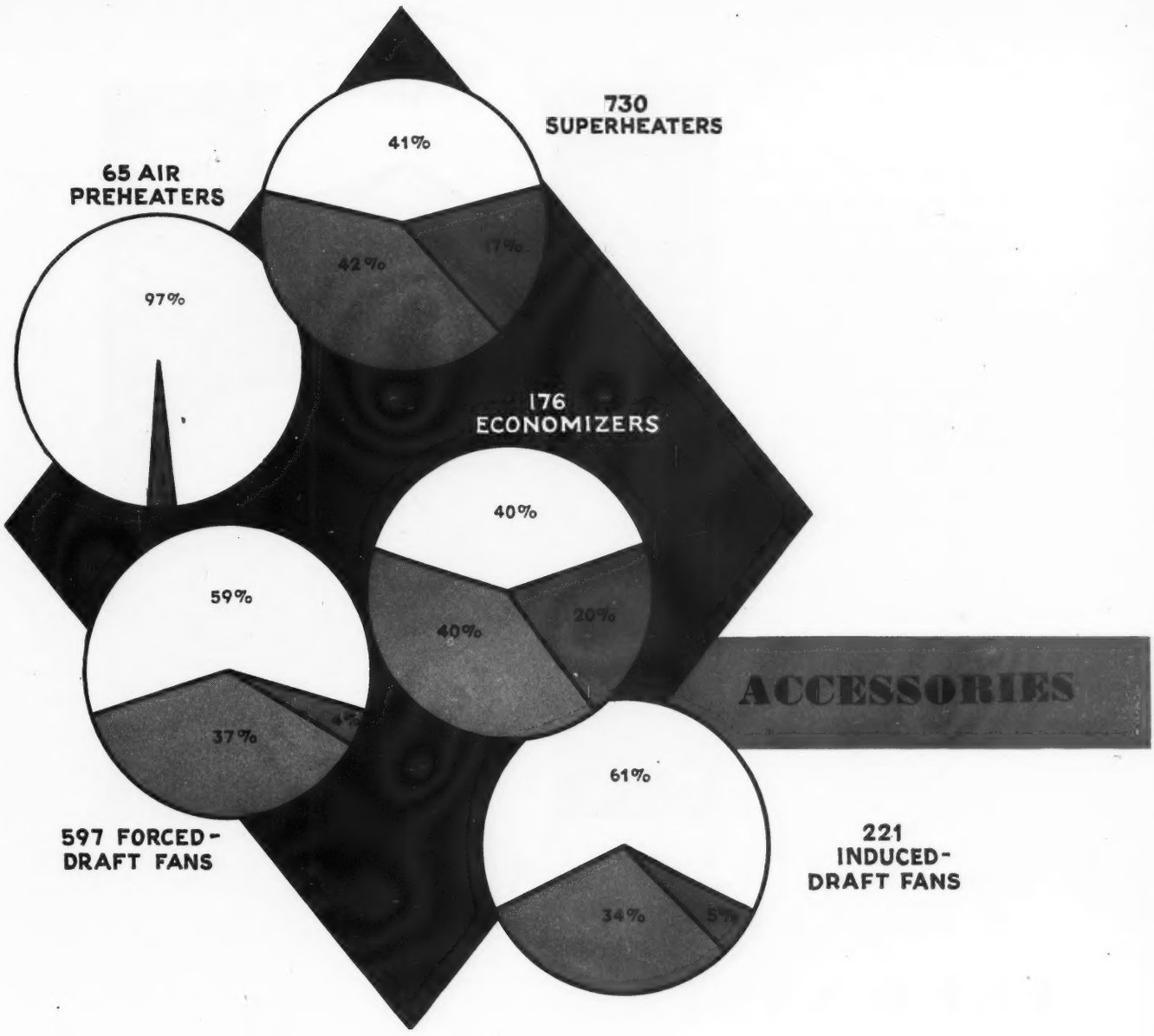
BEYOND any question, the most effective device for getting rid of good coal is an old-fashioned shovel pushed by a pair of well-developed biceps. In the long run an athletic fireman, anxious to earn his wages by heaving plenty of coal, will cost you more than a first-class professional football player. If you insist on hand firing, pick a man who is physically lazy but handy with a lead pencil and fond of looking at instruments. Actually, hand firing is completely obsolete today, except for standby units.

Hand stokers have a real place for small units on moderate loads. Where steam output is large, the choice must be among automatic stokers, pulverized coal, oil and gas. Gas must be considered in some regions. Oil is more widely available and in many places will fit better than coal. Nevertheless, coal is now, and will continue to be, the primary steam fuel for stationary plants.

Kinds and prices are legion, varying all over the United States. These variations, together with local plant conditions, affect the choice between stokers and pulverizers. Only an engineer can make the proper selection. He must particularly consider present and future fuel markets, selecting equipment to handle any coal that may be cheapest on a heat-unit basis.

Most old stokers and pulverizers are far surpassed by today's best units, in capacity, efficiency and ability to burn a wide range of coals.

The margin can easily be determined by getting prices and guarantees. With these figures in hand, one can determine at once whether existing firing is obsolete (see page 704).

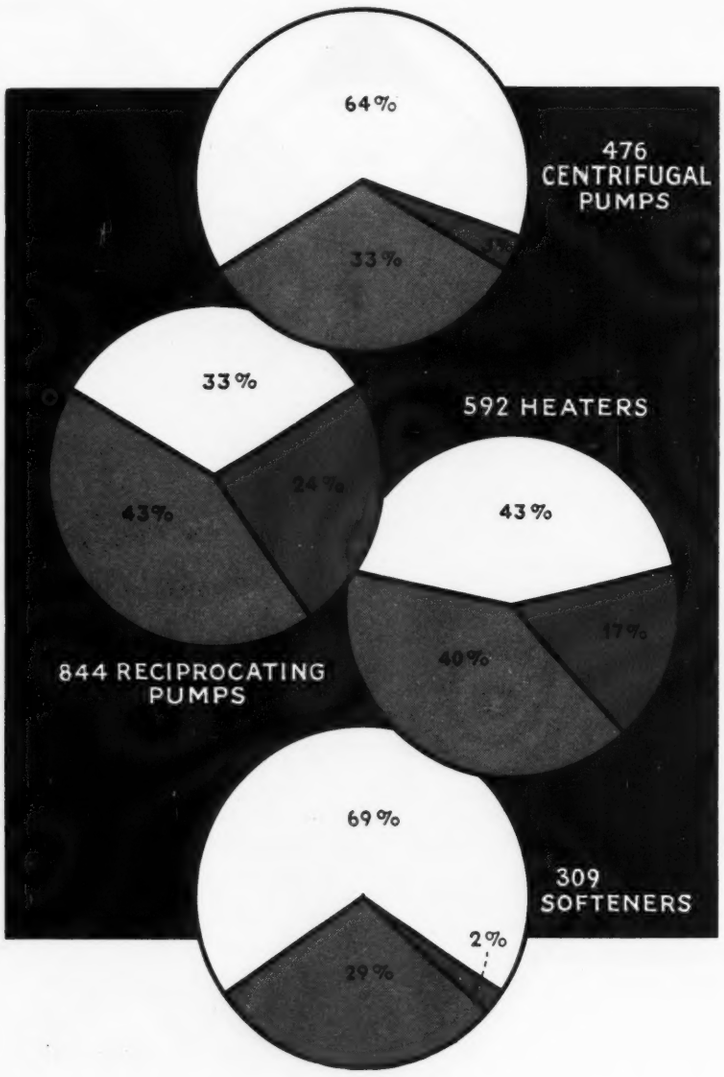


EVEN good boilers and good firing equipment don't insure a good boiler plant. No other units require as much expert assistance to do their job right. They generally need draft fans to keep boiler investment working at good load, air preheaters and economizers to salvage waste heat, superheaters to make the steam produced acceptable to efficient prime movers, particularly turbines.

The age and obsolescence status of those accessories covered by the Survey pretty well pigeonhole the plants reported as first class, second class or worse. Almost equally important, but not reported in the Survey, are soot blowers, instruments, automatic control—all essential to highest efficiency.

Altogether, the difference between adequate and inadequate accessories may easily mean 10 points on steam operating costs. It is not implied that economizers and air heaters are always paying investments. Sometimes they are not, but they have an important and increasing place in the modern boiler plant. With high steam pressures particularly, they are a practical necessity, not only to increase efficiency by salvaging waste heat from the flue gases, but also actually to reduce the cost of the installation. The water in a high-pressure boiler is very hot and much less effective as a heat-absorbing agent than the cooler water in an economizer. The air preheater, likewise, can do more work when attached to a high-pressure boiler.

Good operation is impossible without an ample assortment of modern instruments. Boilers cannot be run "blind" with good efficiency. With instruments, consider automatic regulation to maintain test efficiency, always.



FEED SYSTEM

PRACTICALLY all natural waters, except rain water, cause scale in troublesome quantities, as all power engineers have learned to their sorrow. The typical attack on this enemy has been a gradual evolution from periodic scale-removing jamborees through indiscriminate dosing with costly nostrums to scientific water treatment. Today, aside from distillation (which is generally too costly under industrial plant conditions) nothing except scientific water treatment is worth considering. Savings by avoiding cleaning labor, excessively priced patent compounds, burned-out tubes and wasted fuel make it cheapest in every case. The only room for choice is among the various scientific treatments. These include chemical and zeolite softeners, chemically controlled boiler-water conditioning, deconcentration and continuous blowdown. Water analysis varies from plant to plant and from day to day in the same plant. Proper water treatment varies with boiler operating conditions. The choice of treatment is therefore a technical problem for engineers trained in such matters.

Feed water should be as hot as possible to save fuel and prolong boiler life. Obsolescence of old heaters is measured by how far they fall short of possible temperatures and also (in the case of open heaters) how completely they "deaerate"—remove the oxygen which is the chief cause of corrosion. Modern open heaters are much superior in this respect.

Direct steam-driven reciprocating feed pumps are notorious steam eaters. Their replacement by modern centrifugal pumps greatly reduces the production of exhaust steam. This is decidedly important in all cases where the total exhaust from all sources exceeds the demands of the process and heating systems.

CHEAP POWER

POWER's equipment survey divides naturally into two main parts, boiler room and engine room. Traditionally, the boiler room presents the greater opportunity to save power dollars. This is certainly true as far as operation is concerned, because steam-generating equipment requires continuous attention and slumps in efficiency the moment attention is relaxed.

In the matter of savings obtainable by better equipment and hookup, boiler room and engine room are about on a par and must often be considered together. This is notably true of steam pressures, which, in turn, are closely tied up with the remarkable savings opportunity designated by such expressions as "byproduct power" and "heat balance."

Remember that we are speaking solely about industrial, institutional and building plants, wherein the conditions and objectives are, in general, totally different from those in steam-electric central stations. The latter invariably operate condensing and have the simple problem of using as little steam as possible to generate a single service—electricity.

Most industrial plants operate non-condensing, or at least with only a fraction of the throttle steam going to condenser. They generate at least two services simultaneously: electricity and low-pressure steam for process and heating.

The central station must throw away the exhaust heat of its turbines, whereas the industrial plant should reuse this as far as possible for process and building heat. Credit for this useful exhaust greatly reduces the steam and coal chargeable to power generation.

In the ideal case, approached in many process plants, all of the engine or turbine exhaust goes to process and heating, so that the net coal chargeable to power is only 0.4 lb. per kw.-hr., less than half that of the largest and most efficient central stations. When this condition is attained, we say that the plant has achieved "heat balance" and that all power is produced as a "byproduct" of process and heating steam.

In simple language, then, the problem is to decrease the steam consumed by engines and turbines until it is always less than the steam required for process and heating.

The obvious first step is to consider more efficient engines and turbines, modern units of much better design and without the wear that has piled up depreciation on top of obsolescence.

But this may not be enough. It depends on the balance of heat and power loads in the given factory.

If better prime movers won't turn the trick, concentrate on steam pressure (along with necessary superheat). Study the effect of increasing boiler and turbine pressure to 300 lb., 400 lb., or even 600 lb. At the same time see whether process pressures can't be lowered to permit greater expansion of the steam in the prime movers.

Steam pressures up to 600 lb. have become common practice in such progressive industries as pulp, paper and chemicals. By their use waste of exhaust steam to condensers and atmosphere has been largely eliminated and millions of power dollars saved yearly. The same road to profits is open to other industries.

Note that there is no fixed rule here—no standard practice. The pressure that is right for one industrial will be wrong for another. In some cases the old engines or turbines are giving a heat balance—but figure it out.

In no case consider either boiler or prime mover modernization without, at the same time, studying steam pressures. A new boiler, engine or turbine purchased for operation at the existing, instead of a higher, pressure may be a millstone around the neck of future profits. Study present loads, future possible trends. Pick a pressure high enough to be on the safe side, whatever happens.

Low power cost demands cheap steam and little of it. It also involves elimination of waste in power transmission and application—metering of electrical consumption by manufacturing departments, better motors and mechanical drive equipment, better layout and grouping of these drives.

POINTERS

Prime ingredients of cheap power:

1. Cheap steam
2. Little of it.
3. Less waste in application

Answer to 1 lies in the boiler room.

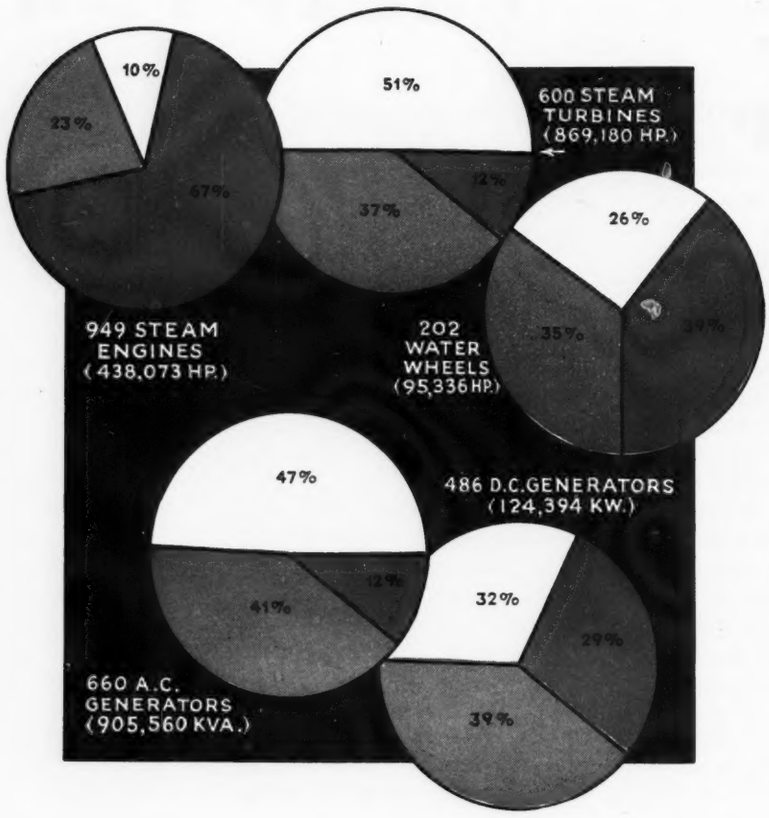
Answer to 2 may be found in:

A. More efficient units
B. Higher steam pressure
C. Better load scheduling

Answer to 3, in part:

A. Meter departments.
B. Better drives

PRIME MOVERS



THE place of the prime mover in power-dollar economy has already been covered largely in the previous article, "Cheap Power." A few additional comments may be of interest. In the plants surveyed 67 per cent of the installed steam-engine horsepower is more than 20 years old. On the assumption that old equipment is necessarily obsolete, this would appear to be a very bad showing. We must point out, however, that this is not always true. An old engine may, or may not, be "obsolete." Its steam consumption will generally be higher than that of a modern engine, but this cannot be called a defect if no exhaust is wasted to condenser or atmosphere at any time. Unfortunately, this condition does not generally exist. Where it does not, the old engine may waste large sums yearly, probably enough to justify the cost of a new unit.

Similar comments may be made regarding turbines. For non-condensing operation, engines are generally more efficient. Turbines, on the other hand, are adapted to bleeder operation and are more efficient for condensing operation. Turbines are also cheaper. Only a skilled engineer can work out the best combination for a given plant.

Although thousands of diesel and gas engines are used in industry, only a few were reported in the larger-than-average plants surveyed. Because their limited number would give an unfair picture, they have been omitted from the report. The point should be made, however, that the internal-combustion engine is today a very important industrial prime mover and should be carefully studied in connection with any modernization program.

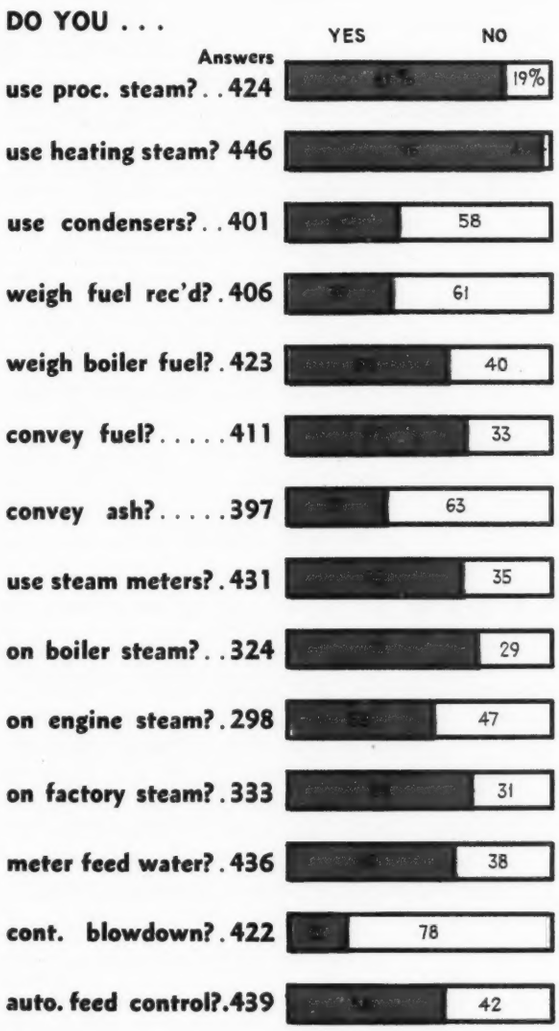
Because of its phenomenal efficiency, even in small units, the diesel engine has moved ahead rapidly in recent years. Real dependability has been achieved. Investment costs have been lowered.

Even for a given region, with given prices for boiler coal and diesel oil, one cannot arbitrarily say whether a diesel is better or worse than an engine or turbine. The choice is affected by the byproduct power situation. In general the diesel is favored by situations where the demand for heating and process steam is relatively small compared to the power load.

Possibly less important nationally than the diesel, the gas engine demands consideration wherever cheap natural gas is available.

A surprising feature of the survey is the number of water wheels and turbines reported.

QUESTION MARK



PRACTICALLY all of the 454 plants furnishing data answered two groups of questions. Replies are summarized in the bar charts on this page and the next. As might be expected, the bar charts presenting the answers to the "Yes or No" questions show that most of the plants meter both steam and feed water. 71 per cent meter boiler-room output, 53 per cent the consumption of engines and turbines, 69 per cent the steam to manufacturing departments, 62 per cent the feed water. Not a bad showing as plants go, although the 35 per cent which do not meter steam at all must offer real possibilities for saving.

The reader may note an apparent discrepancy in that 65 per cent said yes to "do you meter steam" and 71 per cent said yes to "do you meter boiler output." This is explained by the fact that 431 replied to the first question and only 324 to the second; those who had already indicated that they did not meter steam generally omitted any answer to the other question.

Experience shows that a monthly cost distribution, based on true metered quantities, places each power-service producing and consuming department on its mettle and produces savings all along the line. Consider factory departments, for example. It is not in human nature for them to get greatly exercised over wasteful steam use in process and heating unless it is laid directly on their own doorsteps.

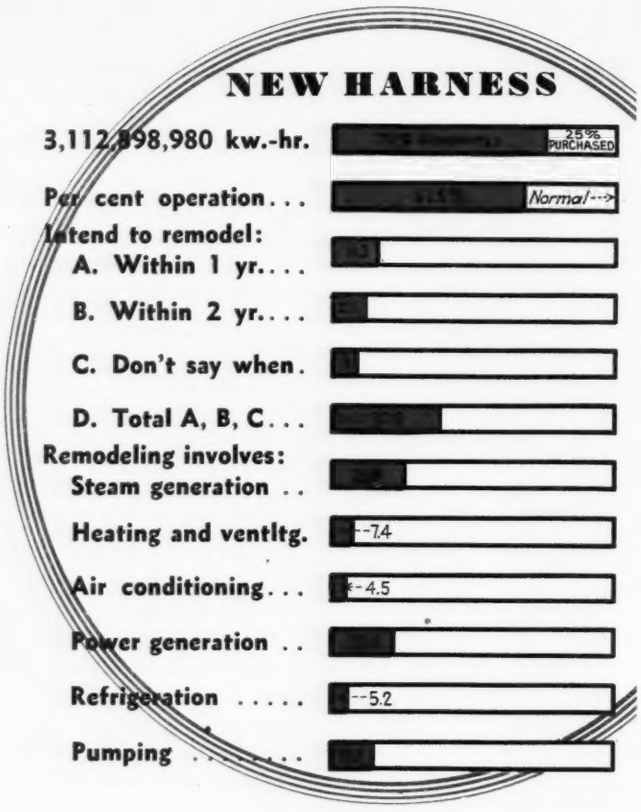
The group surveyed shows practically 100 per cent use of heating steam and 81 per cent use of process steam. Less than half use condensers even in part. This brings to mind a composite picture of plants generating large amounts of power as a byproduct of heating and process steam, a condition especially favorable to low generating cost, particularly in plants of fair size, as these are above average.

Apparently the plants surveyed find local generation to be in general cheaper for their conditions. Note (charts on following page) that 75 per cent of all the power they used in a year was locally generated, 25 per cent purchased. If one should attempt the impossible—a survey of all industry including, for example, 48,000 food plants alone, mostly very small—the picture would of course be quite different.

39 per cent of the plants weigh fuel as received and 60 per cent weigh fuel to the boilers. No check of the questionnaires has been made to see how many plants do neither—probably very few, because some coal weight is needed to check fuel billings and inventories, if nothing else.

All those plants that do not now weigh fuel to boilers would seem to be missing an excellent opportunity to save in two ways, by decreasing both the unit cost of the steam produced and its consumption. Steam meters on the boilers, together with coal measurements to them, give the basic data of boiler efficiency, although feed-water measurement can replace the measurement of steam for the boiler room as a whole.

Of the plants surveyed, 33 per cent seem to be an open field for saving by the mechanical handling of fuel to lower labor costs and improve plant morale.



The same reasoning cannot be applied to all of the 63 per cent that do not handle ash mechanically. Some of them burn oil or gas—produce no ash.

For years there was a persistent prejudice against automatic feed-water control, even among the most competent engineers, on the theory that it causes firemen to get careless about watching water level. The fact that 42 per cent of plants in this group still use no automatic feed control probably indicates that this feeling still persists in spite of the growing acceptance of the general principle of automatic control in all parts of the power plant.

The answers grouped under the heading "New Harness" deal with present and future loads and the equipment to carry them efficiently.

During the year ending June 30, 1934, the 454 plants surveyed generated 2,333,226,318 kw.-hr. and purchased 779,672,662 kw.-hr., a total of 3,112,898,980 kw.-hr. What this means in money cannot be stated, but if we arbitrarily take 2 cents as an average round figure for the unit cost of all power used, both generated and purchased, we see that we are considering a yearly expense, for electricity alone, of around $60,000,000.

The total power cost of this group includes also that of transmitting and applying this electricity and the cost of generating, transmitting and applying all of the other power services.

As reported, the year's load was estimated to be 67.5 per cent of normal. The remaining 32.5 per cent represents further potential increase in cost as business picks up. In some cases this may also mean bringing obsolete standby units into operation, because modern units cannot be installed in time.

Most significant of all are the answers to the questions regarding plans for modernization. Of the plants surveyed, 37.9 per cent plan to modernize—three-quarters of them within the next two years.

As might be expected, steam and power generation will get the most attention. Appreciable numbers will go after heating and ventilation, air conditioning and refrigeration. That nearly half are planning to modernize pumping is interesting, but should not be surprising when one considers the recent enormous improvement in pumps and pump drives and the many unscientific installations made in the past.

There is no way to tell from this end of the line how much money will be saved by these projected modernizations, but it will be interesting to hazard a very rough guess in the matter of power generation alone.

Suppose that the net effect on those plants modernizing power is a saving of 2 mills per kw.-hr. on the aggregate kilowatt-hours generated and purchased. Some 22.6 per cent of the plants surveyed plan to modernize power generation. Their yearly consumption at present is about 700,000,000 kw.-hr. At 2 mills this would come to a yearly saving of $14,000,000. To this must be added the savings in power cost resulting from the additional modernizations of boiler rooms alone.

Whether the actual savings prove higher or lower than this guess, they will most certainly run into millions annually for this group of plants, with more millions saved in the other ways indicated.

IN CONCLUSION

POWER has surveyed 13,329 equipment items in 454 better-than-average plants, representing 9.2% of America's industrial prime-mover capacity, in 14 industry classifications. 65% of these items are more than 10 years old. These articles report the outstanding findings for the combined 14 industries. January *Power* will present a complete tabulation with interpretation, industry by industry.

It is estimated that American industry wastes, on the average, 50 cents out of each power dollar. This can be salvaged by better operation and replacement of obsolete equipment. Most of the 20-yr. old units are obsolete, as are many, also, in the 10-20 yr. age group. Executive cooperation is needed to eliminate this waste.

Where executives work hand in hand with engineers to get 100 cents in service for each power dollar expended, the industrial concerned steps down its total production costs by 1½ to 5 per cent, and immediately gains that competitive advantage over the great mass of plants that neglect this field of saving.

A.S.M.E. CENTRAL STATION SESSION TALKS

STOKERS

Power Week, with the annual meetings of the A.S.M.E. and A.S.R.E. and the Power Show, was observed in New York the week of Dec. 3 to 8. Much data worthwhile to power engineers taken from papers, discussion and visits, are here reported

HIGH-PRESSURE-STEAM AND BINARY CYCLES

QUITE a number of papers have been presented before the A.S.M.E. reporting the result of studies of the effect of high temperatures, high pressures and various steam cycles on power plant efficiency. But none of these has included a study of the various possible binary vapor cycles. G. A. Gaffert in "High-Pressure-Steam and Binary Cycles as a Means of Improving Power-Station Efficiency," presents the principal results of an extensive study made on the possibilities of the mercury-steam cycle, diphenyloxide-steam cycle, aluminum-bromide steam cycle and Dr. Koeneman's zinc-ammonium-chloride cycle. Included for comparison are studies of cycles using steam alone at very high pressure and temperature. Analysis of these cycles was not theoretical, as consideration was given to turbine efficiency, boiler over-all efficiency, terminal-temperature differences, pressure drops in piping, radiation losses, and power consumed by auxiliaries.

Throughout the paper a plant capacity of 50,000 kw. was assumed so that quantities and other features for steam and binary cycles may be compared. Steam conditions considered were at pressures of 1,200, 2,500, and 3,226 lb. pressure at steam temperatures of 800 and 1,000 deg.

In the study of mercury-steam binary cycles, it is reported that there is a best back-pressure for the mercury turbine. This was found to be at 4 in. mercury absolute. The possibility of extracting mercury for preheating the mercury liquid while being pumped back to the mercury boiler was also considered. However, the steepness of the saturated liquid line as indicated by a temperature-entropy chart showed that very little improvement in cycle efficiency could be obtained in this manner. A very real gain, however, obtains in extracting the steam turbine for feedwater heating. It was also determined that for 2-point extraction on the steam turbine the rate of mercury circulation increased almost directly with back pressure, while for 4-point extraction on the steam turbine the rate of circulation remained almost constant.

In studying diphenyloxide as a fluid for binary cycles, it was necessary for the author to undertake experimental work in order to determine the thermal characteristics of the diphenyloxide. The result of this research is given in the paper in a Mollier chart.

As in the case of the mercury-steam cycle, a best exhaust pressure was found for the diphenyloxide steam cycle at 25 lb. absolute. This showed that from a thermal standpoint the cycle is on a par with the highest pressure steam cycle. Mr. Gaffert, however, recommends 800 deg. as the safe upper limit temperature as beyond this decomposition of the fluid may be encountered. There is also a problem of condensation as considerable superheat exists in the exhaust from the diphenyloxide turbine, thus requiring abnormally large condensing surface.

An economic analysis comparing the diphenyloxide-steam cycle with the mercury-steam cycle shows that when mercury and diphenyloxide vapor temperatures are limited to 800 deg. and steam superheat to 1,000 deg., there is practically an economic balance with $2 per ton coal. With the higher temperatures and higher fuel costs the advantage is wholly with the mercury-steam cycle.

From the few known physical properties of aluminum bromide it was found that this fluid as a binary cycle medium has considerable thermal promise. However, aluminum bromide combines chemically with water forming hydrobromic acid. The latter corrodes most metals used in power generation practice and is dangerous to life, making it advisable to consider other fluids first.

Dr. Koeneman's zinc-ammonium-chloride binary cycle also has considerable thermal possibilities. At high temperatures this cycle carries with it decomposition of ammonia and probability of metal corrosion.

Some of the conclusions given are:

High-pressure-steam plants show a decided thermal advantage even when auxiliary power is considered, and there is considerable margin available for increased capital costs. Analysis indicates that higher pressures are economically justified and that the steam cycle has not yet reached its limit.

When metals become available (at reasonable cost) which will withstand 1,000 deg. continuously, the mercury-steam binary cycle will show considerable over-all economic advantage, and at higher temperatures it is the only feasible cycle. No thermal advantage is obtained by bleeding the mercury or diphenyloxide turbines in a binary cycle for the purpose of preheating the boiler-feed liquid. When thermal advantages and capital costs, with particular reference to fluid costs, are considered in binary cycles, there is little choice between mercury-steam, diphenyloxide-steam, and high-pressure-steam cycles, assuming low fuel cost and 800 deg. initial temperature.

Discussion

PROFESSOR ELLENWOOD agreed with the author that with 1,200 lb. pressure the best reheat pressure is at 200 lb. when the initial temperature is 800 deg., and that this pressure drops to 100 lb. with an initial temperature of 1,000 deg. He commented that the performance of binary plants, shown by curves below 9,300 B.t.u., indicated thermal efficiencies better than obtainable with present internal-combustion engines. Mr. Sheldon pointed out that, to secure the most effective use of high temperatures in increasing cycle efficiency, this temperature should be the saturation temperature and that mercury vapor offers the best opportunity for further improvement when higher temperatures become possible. In answer to questions concerning reliability, Mr. Sheldon gave the following figures for performance at Kearny and Schenectady:

	Kearny	Schenectady
Hours in operation	6,259	2,946
Availability factor	56%	68%
Capacity factor	37.2%	34.4%
Kw. generated	82,245,000	29,923,000

Mr. Greeves agreed with the author that diphenyloxide should not be used at temperatures above 800 deg. He pointed out, however, that it was unnecessary to employ forced circulation in boilers using diphenyloxide. He suggested using a fluid more volatile than water in a binary cycle using mercury as the primary fluid.

G. A. Hendrickson pointed out that the theoretical figures as given by the author were never obtained in practice because of the effect of varying turbine loads, banking and burned-out losses, and steam

leaks. He felt that a plant operation factor should be applied to such figures before making comparison and that this allowance should be about 10 per cent.

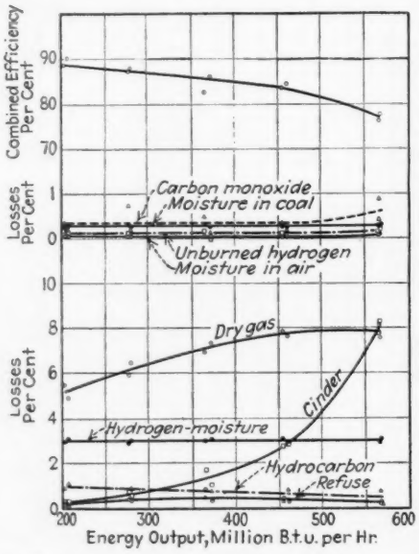
J. A. Duncan pointed out that aluminum bromide is not corrosive if all of the metal is submerged, but if temperature differences exist in the metal corrosion will always result. Mr. Hackett indicated that 125 hp. is required to drive the mercury pumps which feed 2,100,000 lb. of mercury per hr. to the mercury boiler at Schenectady.

In closing, the author agreed that a plant operation factor should be applied, but felt this would vary for each plant and should be used when making plant studies. He pointed out that once water is mixed with aluminum bromide the water cannot then be separated and the mixture becomes corrosive.

TEST NEW STEAM-GENERATING UNIT AT HUDSON AVENUE

DURING acceptance tests made on recently installed steam generating units at the Hudson Avenue Station of the Brooklyn Edison Co., boiler losses were measured which usually appear in the unaccounted for items of the heat balance. In "Test Performance of Hudson Avenue's Most Recent Steam Generating Unit," P. H. Hardie and W. S. Cooper described methods used for measuring these losses, which include losses due to unburned hydrogen, hydro-carbons carbon monoxide and carbon loss in the cinders. The completeness with which these losses were measured is evident from the low value obtained for the radiation and unaccounted-for items in the heat balance.

The tests were made on a Ladd type boiler of 24,450 sq.ft. heating surface



Test-performance curves, efficiency and energy balance

equipped with a furnace water-wall of 3,840 sq.ft. surface, a superheater of 5,740 sq.ft., and an economizer of 22,400 sq.ft. Furnace volume is 14,000 cu.ft. The unit is fired by an underfeed stoker of 15 retorts and 69 tuyeres long, having a projected grate area of 694 sq.ft. The stoker wind-box is equipped with a zoned-air control which permits hand control of the rate at which air is supplied to sections of the grate.

In preparation for the test, the setting was tested for leaks by closing the flue damper and operating the forced-draft fan, while a dense smoke was produced with titanium chloride. All visible leaks were eliminated. Except for two runs at highest load, testing was continuous without recesses between runs. The highest load on the boiler was 504,200 lb. of steam per hr., requiring a combustion rate of 75 lb. per sq.ft. of projected grate area. The efficiency reported at this load is 77.5 per cent. The highest efficiency reported is 90 per cent at a load of 174,400 lb. per hr.

Special continuous gas samples collected over mercury were taken to the laboratory for special analysis. Per cent of carbon-monoxide was determined by an iodine-pentoxide train. Presence of hydro-carbons was determined by a modified Burrell-Oberfell apparatus, which also permitted determination of unburned hydrogen. These determinations showed the presence of unburned hydrogen varying from 0 to 0.06 per cent and unburned hydrocarbon varying from 0.02 to 0.21 per cent. While the unburned hydrogen loss was consistently negligible on these tests, the hydrocarbon loss was sufficiently large on all runs to justify its measurement. Its maximum average value was 2.4 per cent.

The difference between the laboratory and field analyses for CO is not appreciable, except on a few of the runs where the two values of CO were in excess of 0.1 per cent by volume. Based on these tests, one might reasonably conclude that use of an iodine-pentoxide train is not justifiable, although previous tests had shown the reverse to be true.

Cinder sampling was done in a vertical length of duct between the economizer outlet and the cinder catcher by means of twelve 1-in. sampling tubes. Inlet ends of the tubes were placed at the centers of twelve equal areas. Each tube extended out of the duct into a large glass jar and had attached to its end a wool filter bag. A second tube led out of each jar to a flow nozzle, which discharged into a manifold connected to a steam ejector. The rate of flow for each sampler was regulated to give a velocity through the sampling tube equal to the velocity in the duct at the respective points as determined by means of a pitot-tube traverse made prior to the test. The heat balance detail of these tests is shown by the curves in the illustration.

STOKER DEVELOPMENT AT HUDSON AVENUE

IN "Ten Years of Stoker Development at Hudson Avenue," J. M. Driscoll and W. H. Sperr describe and illustrate five different types of stokers installed there, together with changes made to some in an effort to obtain the capacity required. The station was started in 1922 with 14 retort underfeed stokers of 365 sq.ft. of projected grate area, and was completed in 1932 with an installation of 15 retort stokers of 694 sq.ft. projected grate and ashpit area. These latter stokers, 69 tuyeres long, are the longest single-ended underfeed stokers in operation, measuring 26 ft. 7 in. from front furnace wall to rear of ashpit.

The original stokers were designed for a combustion rate of about 55 lb. of coal per sq.ft. of grate area per hr., but draft conditions made it impossible to reach the designed combustion rate. The last stoker installation was designed for a continuous combustion rate of 65½ lb. of coal per sq.ft. per hr., with a 5-hr. rate of 73 lb. During acceptance tests this stoker, after the addition of air control equipment, was run for 48 consecutive hours at an average coal-burning rate of 75 lb. per sq.ft. per hr.

The authors point out that the fuel-burning rate at which stable operation for long periods can be maintained is apparently limited, on purely underfeed stokers without zoned air control, to about 55 lb. per sq.ft. per hr. This was observed on two types of stokers. In one case the addition of link grates increased the fuel combustion rate from around 53 lb. to 62 lb. per sq.ft. per hr. This was the first installation of this type of stoker. The addition of zoned air control to the 69 stoker increased the combustion rate from about 55 lb. per sq.ft. per hour to 75 lb.

The paper also gives efficiency curves for the various units at Hudson Avenue, together with operating data, which includes average steaming rate, average coal-burning rate, average steam-generating efficiency, stoker maintenance.

Discussion

A NUMBER of discussions pointed out the importance of combustible lost in the cinders at high load, which is largest excepting dry gas loss. Various methods of recovering cinders and reburning in the furnace were suggested. That this was the first really close determination of radiation loss was pointed out by Professor Ellenwood, who also expressed the opinion that the loss due to unburned hydrocarbon was low due to distance of boiler tubes from stoker and that these tests indicated high efficiency was not confined to pulverized coal installations.

Mr. Keppler compared the results of the tests on the pulverized fuel fired boilers at Hell Gate as reported by Mr. Caldwell in a previous paper with the Hudson Ave. tests. He suggested the use of overfire air to reduce unburned hydrocarbon loss.

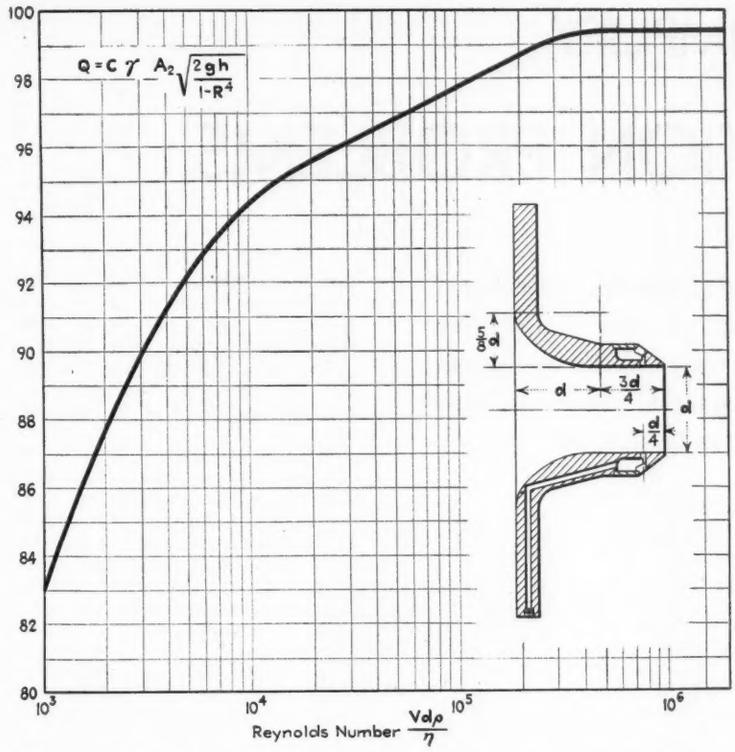
In Mr. Herschberg's opinion the method of continuous testing used by the author caused errors due to different thickness of fuel bed at start and end of each run and that erratic radiation losses reported were the result of this error.

That the hydrocarbon loss must be considered when determining the amount of excess air necessary for best performance was pointed out by E. C. M. Stahl.

FLUID-METER NOZZLES

AS TURBINE sizes have increased, the cost of installing weighing equipment for measuring condensate during performance tests has become prohibitive, and this equipment has been omitted. In a number of such cases some form of equipment sufficiently accurate to measure the flow of condensate for turbine acceptance tests was needed. Flow nozzles developed to satisfy this need were described, together with their calibrations, by B. O. Buckland. Seven nozzles have been built and used to measure the flow of condensate during turbine performance tests. They range in size from 1¼-in. diameter (used to measure the condensate from a 10,000-kw. turbine) to 5-in. diameter (used to measure the condensate for a 160,000-kw. turbine).

The form of this nozzle, together with its dimensions in terms of nozzle diameter,



Flow coefficients plotted against Reynolds' number, and at right, method by which static-pressure taps in nozzle throats are connected to manifolds

are illustrated. The approach curve to the cylindrical throat is a quarter-ellipse machined by the use of a cam. The four static pressure holes in the throat of the nozzle were made as follows: After the inside of the nozzle was machined to a final form and polished, a plug was snugly fitted into the nozzle throat. Static pressure holes were drilled through into the plug and reamed. Then the plug was carefully removed and the holes inspected with a magnifying glass. Generally, they are fairly clean, but a wire edge may be left. This is removed by alternate reaming and rubbing with a wood black.

One static pressure hole for the upstream pressure measurement is drilled in the pipe one diameter ahead of the face of the nozzle flange.

The ratio of nozzle diameter to pipe diameter covered by the group is from 0.20 to 0.50.

These nozzles were calibrated in the hydraulic laboratory of the University of Pennsylvania by Prof. W. F. Pardoe. Four of the seven have been calibrated in two sizes of pipe, so that there are 11 calibration curves on the seven nozzles.

Flow coefficients resulting from tests on all of the nozzles are plotted against Reynolds' numbers as shown in the illustration. The point falls very nearly on one curve, except for the data obtained on three small nozzles. These nozzles are included because they show the trend of the curve at the lower Reynolds' number.

Comparison of the calibration results with those of other nozzles shows that the nozzles with a gradual approach curve and an appreciable length of cylindrical throat have coefficients which change less abruptly with changing Reynolds' numbers than nozzles with rapidly curving approach and short parallel throat.

Discussion

MR. MOSS pointed out that the effort had been to design a nozzle which would give, as nearly as possible, theoretical flow, and that its design and use differed greatly from that of commercial flowmeter practice. E. D. Dickinson remarked that he depended upon calibrated nozzles for flow measurements, but using differential pressures higher than in commercial flowmeter practice. Considerable discussion developed on the relative merits of measuring throat pressure by taps in the pipe and by the method employed in the G.E. flow nozzle.

Professor Pardoe reported tests in which simultaneous readings of throat and pipe tap pressures were made with only ½ per cent difference between them. Difficulties in using pipe taps because of interference with flange hubs was pointed out by W. A. Carter. He also expressed the opinion that many operators of condensing turbines would be happy to use calibrated nozzles for turbine acceptance tests.

Some discussion developed on the effect of swirl of the flowing fluid on the accuracy of nozzles. It was indicated that swirl had a large effect when the fluid measured was compressible, but was of much less importance when flow of liquids, such as water, was involved.

COAL CHARGES FOR BANKING, LIGHTING, BURNING-OUT

ANALYSES of coal consumption during banking, lighting and burning out of boilers were described by G. C. Eaton. The unit tested was a 14,479 sq.ft. straight-tube, sectional-header cross-drum boiler with integral convection-type superheater set above a refractory lined furnace fired by a 13-retort, 25-tuyere underfeed stoker of 303.4 sq.ft. of projected grate area, equipped with a double-roll clinker grinder.

The results of the banking tests show the following relation:

Hours from Start of Bank	Net Banking Charge Lb. Coal per Hr. per Sq.Ft. of Projected Grate Area
2.5	3.44
5	3.11
7.5	2.90
10	2.64
15	2.31
20	2.11
30	1.91
40	1.81

The lighting tests show a net charge of 76.0 lb. per sq.ft. of projected grate area, and the burnt-out tests a net credit of 54.8 lb. per sq.ft. of projected grate area. Due account was taken in all tests of the heat value of the steam made during the periods involved.

Included is a comparison between the above results and previously published data. The possible effect on stoker, furnace, and boiler maintenance, as well as boiler water problems, is omitted.

Discussion

REPORTING data from tests made at Hell Gate, S. S. Grob indicated that the coal loss in burning out and starting up boilers when using pulverized coal was 1/3 the loss for stoker-fired boilers.

HEAT TRANSFER IN BAFFLED TUBE BANK

ONE of the chief obstacles in determining the heat transfer in shell-and-tube type heat exchangers equipped with cross baffles is the choice of an area on which to base the mass velocity. R. A. Bowman suggested that the free area at the center of the shell, between adjacent baffles, be used. This gives values which are too high, since there is always a certain amount of leakage through and around the baffles. He developed methods of correction for this leakage from pressure drop consideration. This correction depends on a constant which is a function of the clearance around tubes, and between baffles and shells, and on the pressure drop coefficient.

A given line of heat exchangers would have approximately the same constant, and a logical way to determine this constant would be to choose it so that the test results will be brought into agreement with the curve given by Colburn.

This has been done for a group of eleven similar oil coolers. The test results, shown in the paper, are brought much closer to mutual agreement and approach the given curve rather closely.

Unfortunately, the tests are all of rather low Reynolds' number. Tests are contemplated which will extend the results over a larger range.

BETWEEN LIQUID AND GAS

AT THIS session A. Weisselberg presented a paper discussing heat transfer between liquid and gas in contact with each other. The available emperical formula were examined and results obtained from their application compared to demonstrate the need of more reliable information. An analogy was drawn between heat transfer and vapor mass transfer.

NEW METHODS SIMPLIFY

VIBRATION PROBLEMS

Axial oscillation of turbine-generator spindles, an unusual condition, can now be prevented. A new method for dynamically balancing heavy rotating machinery under normal operating conditions uses portable equipment with which a direct solution may be obtained

AXIAL OSCILLATION

RECENTLY three turbines gave vibration trouble of a type which it is believed has never been encountered before. Their rotors, under certain conditions, would oscillate in an axial direction. How this difficulty was corrected was explained in "Investigation of Axial Oscillation of Turbine-Generator Spindles," by J. G. Baker. This trouble was caused by instability of the free vibration resulting from leakage by the dummy piston depending on turbine-spindle axial position and other conditions, a combination unique to these particular machines. A chamber was added in the equilibrium line of each machine to cure the trouble. This chamber functions by changing the phase relations between dummy-chamber pressure and spindle axial movement.

It is remarkable that such trouble has not been encountered more frequently in practice. A number of conditions are necessary in order to cause this oscillation. These include a large-end tightened dummy piston, appreciable flow velocity in the equilibrium line, extremely small damping attendant to axial oscillation of the spindle, an equilibrium pipe length and diameter, a natural frequency of oscillation, dummy chamber size and direction of dummy end tightening in unfortunate relation.

Mr. Baker's opinion is that vibration can be prevented in future designs by avoiding one or more of these conditions.

ROTOR BALANCING

IN "A Mathematical Solution of the Rotor-Balancing Problem," Jacob Bromberg presented an accurate and easily applied method of determining, from results of a dynamic balancing test, location and magnitude of the weight or weights required to eliminate vibration in a rotating mass.

EFFECT OF SKEWING ON MAGNETIC NOISE

OPERATION of rotating electrical machines over a wide range of speeds often leads to emission of an intense magnetic hum, due to resonant vibration of the machine frame at some speed in the running range. S. J. Mikina in "Effect of Skewing Pole Spacing on Magnetic Noise in Electrical Machines" reached the conclusion that to prevent excitation of the four principal modes of vibration of any frame it is necessary to skew the poles or slots one slot space by straight-line or herringbone skewing. The noise due to the first, third and fourth modes of vibration may be appreciably reduced by making the effective pole width equal to a whole number of slot pitches. If it is desired to have the most favorable conditions for noiseless operation, skewing the slots in combination with making effective pole width equal to a whole number of slot pitches should be used.

DYNAMIC BALANCING IN THE FIELD

A NEW method for dynamically balancing heavy rotating machinery in the field, under normal operating conditions, and new portable equipment for obtaining a direct solution of this problem are available. Both method and equipment were developed by Ernest L. Thearle of the General Electric Research Laboratories, and were described in "New Method and Equipment for Dynamic Balancing of Heavy Rotating Machinery in the Field."

The new balancing method is an answer to the growing need for a simple balancing procedure for heavy rotating machinery without taking it to a balancing machine. The need has been particularly apparent in connection with rotors of very large turbine-generators, for which balancing machines are not available. With the new method and equipment, better balance can be achieved in many cases, and in a much shorter time than with the usual balancing machine. Now the balancer is taken to the machine instead of the machine to the balancer.

The new equipment consists of two special generators, a contactor, a meter and control box. In practice, one of the generators is attached to each bearing pedestal of the unbalanced machine and the contactor is coupled to the machine shaft to rotate with it. Both generators and contactor plug into the meter and control box. These generators are so constructed that they produce an alternating electromotive force proportional to the vibration velocity of the pedestals to which they are attached.

To place a machine in balance with the new method, only three balancing runs are necessary. The first run is made with the machine in its normal unbalanced condition, readings of phase and magnitude being taken at the near and far ends. These readings are entered on the standard calculation sheet. A run is then made with a single known weight of any reasonable amount placed in any position on the near end of the machine's rotor. Readings are again taken for the near and far ends, and entered on the calculation sheet. A third run made in the same manner as the second has a known weight of reasonable amount placed in any position on the far end of the rotor.

A series of simple calculations are then made on the standard sheet, giving a solution which indicates the values and positions of final correct weights which will balance the rotor.

Portable dynamic-balancing equipment in a carrying case

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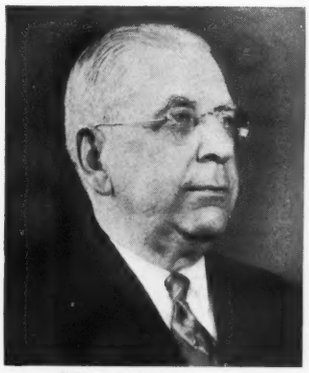

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PRACTICAL

SELECTED DURING

IT IS estimated that the total cost of all power services for American industry (not including mines and quarries) during 1933 was approximately equal to the net earnings of all industry. It is also estimated that, on the average, 50 cents out of each power dollar was unnecessarily wasted. If, therefore, industry had saved only thirty cents of this, the net profits of 1934 operations would have been increased 30 per cent. T he year 1934 is about gone, but this turkey is still on the 1935 platter for those interested.

CAST-IRON crankshafts? Not so long ago the man who suggested them would be called crazy, but today alloy cast-iron shafts are being used in automotive engines and in high-speed diesels.

UNUSUALLY complete boiler tests have shown that the loss due to unburned hydrocarbon may be more important and of greater magnitude than the loss due to CO. These tests also showed that the unburned hydrocarbon may be present even though the percentage of CO is extremely small.

EXCEPTION to the slow development characteristic of depression years is the diesel industry, whose advances have been characterized by C. F. Hirshfeld as "almost spectacular." Higher speeds, superchargers, better design and materials, better performance, less maintenance, and development of solid injection he gives as the contributing factors. His note of warning for the future is possible development of small high-pressure, high-temperature steam plant units which, while having lower thermal efficiency, will have possibly higher economic efficiency due to cheaper fuel.

WEAK SPOTS in machines and other power equipment are shafts at points just beyond the grip of pressed or shrink fits, and flanged openings and cover plates in pressure vessels. Tests show that the customary formulas and rules of thumb for the design of these parts are, in general, either wrong or misapplied. "No chain is stronger than its weakest link." Moral: Designers should watch these danger points.

DETERMINATION of small pressure differentials becomes something of a problem when the pressures involved are of the order of 2,000 to 3,500 lb. per sq.in. The usual glass mercury U-tube of course cannot be used under these conditions. At Purdue University this difficulty was solved by making a mercury U-tube out of steel and observing the mercury levels by taking X-ray pictures.

A SUBSTANTIAL body of experience now indicates that sodium sulphite, properly specified and applied, will remove the last traces of dissolved oxygen from feed water after mechanical deaeration. This is revealed directly by the absence of oxygen indications in chemical tests and, more practically, by the elimination of corrosion and resulting tube failures. It is necessary, however, to have exactly the right grade of anhydrous sodium sulphite. Until standard specifications are available, a chemist should be consulted before treatment.

PITOT TUBES have long been used for measuring the quantity of air-flowing in ducts, though it has also been recognized that these instruments sometimes gives erroneous results. Characteristics of pitot tubes were thoroughly investigated, and it was found that among chief sources of error were swirls in circular ducts.

A NEW balancing method meets the growing need for a simple procedure for balancing heavy rotating machinery in place. This equipment consists of two special generators, one to be mounted on each pedestal of the machine to be balanced; a contactor, meter and control box. The entire equipment can be assembled in a carrying case and taken to the machine.

IN THE PAST it has always been necessary to weigh the condensate in making turbine acceptance tests. General Electric Co. has indicated its willingness to accept the results of tests made when the condensate is measured by nozzles calibrated by Prof. Cardoe.

POINTERS

POWER WEEK

A BEARING, like 'most everything else, can be starved to death, but at first it improves on the reducing diet. If oil flow to a properly lubricated journal bearing is gradually reduced, the bearing's efficiency increases until a point of minimum friction is reached. If the oil supply is reduced only a small amount below that giving best efficiency the oil film ruptures, metal-to-metal contact occurs and the bearing fails.

ELECTRICAL GAGES, developed for measuring eccentricity of shafts rotating in bearings, will measure movements as small as one-millionth of an inch. Tests made for minimum oil film thickness show close agreement with theory all the way down to zero speed.

COMPLAINT is frequently heard that when laboratory investigations are made of bearings, conditions met in practice are not duplicated. Isn't it about time that practice duplicated laboratory requirements by keeping oil clean and in good condition? This will increase efficiency and bearing life, reduce operating costs and insure more reliable service.

WELDING, incorporated in the A.S.M.E. Boiler Code only a few years ago, is today almost standard practice on pressure vessels and piping. Bedplates, machine frames, etc., are likewise being welded—will welding also be standard practice on them some day?

WHICH IS CHEAPER, welding or casting? Cast iron costs 1¼ to 1½ cents a pound at the cupola spout, material for welding 1.8 to 3 cents a pound. The finished casting costs 4 to 6 cents a pound, the finished welding 7 to 14 cents. Thus to make a welding cheaper than a casting, it may have to weigh less than half as much. A welded structure today costs more, requires skilled labor, is not so pleasing in contours, may vibrate more, is less likely to leak, more likely to twist, is 2½ times stiffer. One company uses welding for 1 to 3 pieces of a kind, debates the matter when 3 to 5 pieces are needed, above 5 uses castings.

HYDROCAL is a new instrument to make heat-transfer calculations. This instrument gives a visual indication of temperature gradients that would exist in walls of almost any heat resistance characteristic, and with various quantities of heat going through it.

OSCILLATION is no good, except in screens and pump plungers. It was recently encountered in three turbine-generators which under certain conditions, oscillated in direction of their axes. This had not been encountered before. This trouble was caused by instability of the free vibration resulting from leakage by the dummy piston depending upon the axial position of the turbine spindle and other conditions. This trouble was eliminated by adding a chamber in the equilibrum line between the high- and low-pressure ends of the turbine.

ALL-WELDED structures and castings, instead of competing, may eventually work hand in hand. Reports are that more and more successful work is being done in combining cast steel complicated sections and simple rolled steel structural sections to gain stronger, lighter and longer-wearing units at lower cost. After all, the prime interest of the power equipment user is not in the material, but in the cost of the finished job and the service it will give him.

THE DIESEL is coming along, its greatest advances being in transportation. One company had built 100 diesels for trucks as of Jan. 1, now has over 1,000 in service. Some utilities at last begin to see the light and plan to use local diesel plants in isolated places where long transmission lines are not justified.

WE FIGURE 50,000 lb. per sq.in. tensile strength as normal for ordinary open-hearth steel. But its latent, or theoretical, tensile strength is ten times that figure—ninety per cent is wasted by what man and Nature do to the material during manufacture and fabrication. It's the old story of the weakest link in the chain—steel fails at the weak points created by slag inclusions, gas pockets, etc.

HIGHLIGHTS
OF THE A.S.M.E. ANNUAL MEETING

ONE HUNDRED technical papers. . . . Often six different sessions going on simultaneously—rarely less than four. . . . Special lectures, dinners, luncheons, tours, committee meetings. . . . Hundreds of mechanical engineers meeting here and there, chatting in the lobbies, renewing old friendships. . . . College professors, deans, presidents, engineering leaders in design, consultation and plant operation; run-of-mine engineers on their way up. . . . Scientists feeding grist to the engineering mills. . . . Hundreds of faces somewhat strange and scores of others associated year after year with A.S.M.E. activities back into the dimming past.

This, in brief, is the picture of the Annual A.S.M.E. Meeting held in the Engineering Societies Building, New York, Dec. 3 to 7. About as always.

One again gathers the impression that mechanical engineering is the broadest of all fields, including matters all the way from water chemistry to political economy. Some technical group had to take up the study of men in industry. The M.E.'s did it, ploughing through problems of training, wages, hiring and firing. They worry about power plants, weaving cloth, selecting locomotives, skimming cream, and making automobiles.

Dropping to earth for a moment, it may be said that this year's meeting was, on the whole, well attended and with many fine papers plus, as usual, some duds. Practical offerings along the line of power problems are covered elsewhere. This page is for generalities, for those highlights that add breadth and human interest—and there were many such.

First, of course, the Power Show, where theory and argument found their practical counterparts: see page 731.

Next the annual dinner dedicated to new members, but always, in fact, serving primarily the old, who constitute 98 per cent of those attending.

Finally, there were the outstanding addresses on matters of general interest by leaders inside the profession and out, and the presentations of medals and other awards for engineering achievement.

Honored by medals presented at the annual dinner were Willis H. Carrier, air-conditioning pioneer, and Ralph E. Flanders, incoming president of the Society.

The meetings were conducted without the presence of that secretary whose 27 years of distinguished service made him a great figure in the engineering world. Calvin Windsor Rice had died suddenly, and "in harness," not long before the meeting. His contributions to engineering, his part in securing the Engineering Societies Building as the gift of Andrew Carnegie, his notable contributions to international friendship, were outlined in a special address of appreciation by John H. Finley, editor, New York Times.

On the closing day of the meeting the Council appointed Dr. Rice's successor, C. E. Davies, since 1931 executive secretary of the Society. Product of Rensselaer Polytechnic (1910), Mr. Davies is a lieutenant-colonel of the U. S. Ordnance Reserve Corps and a member of numerous honorary and professional societies. His early background includes manufacturing plant experience and World War service. In 1920 he became associate editor of the A.S.M.E., the following year managing editor and assistant secretary. He was placed in charge of the headquarters office and in 1931 was made executive secretary. He therefore comes to his new office with an ample background of successful administrative experience in Society affairs and a real reputation for executive ability.

C. E. DAVIES
New Secretary, A.S.M.E.

At Stevens Institute, across the river in New Jersey, Harvey N. Davis presided at a special economics session and Geo. H. Houston, president of Baldwin Locomotive and chairman of the Durable Goods Industries Committee, outlined the fundamentals for recovery in terms of these most basic and most depression-hit of all American industries.

Dean Dexter S. Kimball of Cornell, notable figure in all A.S.M.E. meetings, delivered the Towne lecture, "Prophets and Panaceas." Talking, in part, about the New Deal, Dean Kimball saw in it both good and bad; good in such matters as suppression of child labor, bad in confusion between efforts to raise prices here and lower them there.

He recognized the right of government to regulate industry for the common good, but feared over-regulation.

Two past-presidents, Dr. William F. Durand and Dr. David S. Jacobus, were made honorary members. John I. Yellott, Jr., of Stevens Institute was given the Junior Award for his paper on "Supersaturated Steam." Engineering trips and excursions reached many spots of engineering interest: Brooklyn Navy Yard, Kearny (N. J.) Generating Station, Bayway Refinery of Standard Oil Co. (N. J.), Steamship "Monarch of Bermuda," Polygraphic Co. of America, Hudson Ave. Generating Station, Colgate Palmolive Peet Co., Todd Shipyards, New York Museum of Science & Industry, St. John X-Ray Service Laboratory.

Other features of the meeting were extensive entertainment for visiting ladies and college reunions of Brown, Cornell, Harvard, Newark, Rensselaer, Worcester Polytechnic.

As they recede into the distance, these papers, speeches, sights, ideas and contacts will appear not so much A.S.M.E. events as highlights of Power Week, along with the Power Show.

Taken altogether, they spot the end of the old engineering year, tighten the mental belt for the long pull through 1935. This, most Power Week observers feel, will be "up" rather than "uphill," a slow steady continuation of today's climb towards better days.

BETTER METHODS FOR MEASURING AIR FLOW

New information on the characteristics of Pitot tubes and intake orifices will help in preparation of new Fan Test Code. Instrument for measuring pulsating flow described; pulsation in discharge from centrifugal fans is slight

AIR-FLOW IN FAN DISCHARGE DUCTS

LIONEL S. MARKS reported several possible causes of the discrepancies which are sometimes found between pitot-tube traverse and nozzle measurements of the volume of air flowing.

Additional work at the Harvard Engineering School with instruments of greater precision has thus far indicated that pulsations are of small amplitude and varying frequencies, thus apparently can account for but a small fraction of the discrepancies.

Other possible sources of errors studied were (1) errors in the A.S.H.& V.E. Standard Test methods; (2) errors in the pitot tube; and (3) non-axial flow of the air.

With round ducts, the A.S.H.& V.E. Standard Test Code prescribes not less than 20 pitot tube readings at the centers of areas of five equal concentric areas comprising the duct section. This gives correct results if velocity measured at each location is the true mean velocity for its zone. But the mean velocity of the outer zone is not at its center line. The error due to the use of the standard location in the outer fifth of the cross-section is 0.6 per cent, and can be eliminated by locating the outermost pitot tube at $0.961R$ from the center, instead of the standard $0.949R$.

When pitot-tube direction and air-flow do not coincide, the location of the static orifices in the pitot tube becomes important. Prof. Marks has shown in a number of curves the effect of various static orifice locations on measured velocity head for various inclinations of the pitot tube. These curves show that the A.S.H.V.E. pitot tube measures static pressure very accurately, but the resulting velocity head determination falls off rapidly as tube inclination increases. These curves also show that with a pitot tube with static orifices on the sides, top and bottom, the indicated velocity head remains practically constant for an inclination of about 25 deg. on each side of the correct orientation.

Certain types of fan produce a rotational whirl which will persist in the discharge duct beyond the usual point of measuring fan discharge. The influence of a tangential component to air-flow on the accuracy of volume determination by a pitot tube is two-fold. First, the pitot tube is oriented axially, while the air stream is inclined to that direction. If this inclination is known, and also the pitot tube characteristics, it is possible to obtain a corrected reading. Second, the corrected reading gives the correct velocity head of the air, along the tangential path. This must be corrected to give velocity along the path of flow.

Prof. Marks presented curves correcting pitot-tube readings for rotational air-flow, and other curves showing the amount of rotational flow encountered in the discharges of various types of fans. He, however, recommends that straighteners be used instead of attempting such corrections.

Discussion

MR. HAGEN pointed out that pitot tubes, although intended to be identical do not always give smiliar characteristics. He tested five tubes supposed to be the same, and found discrepancies of 3 per cent. Each pitot tube should be calibrated individually. He also reported tests made with nozzles and pitot tubes which were in agreement when corrections were made for the pitot tube readings. He pointed out that the shortened duct would not be satisfactory when poor distribution existed, and also questioned the possibility of vortex conditions as shown by Prof. Marks' paper.

Mr. Peterson expressed the belief that Prof. Marks' paper had shown the errors to which a pitot tube was subject, and that any Fan Test Code should specify that measurements be made by nozzles.

In Mr. Carrier's opinion, the paper makes possible the use of pitot tubes with satisfactory accuracy, and he also pointed out that a swirl makes errors in nozzle measurements the same way as it affects the use of pitot tubes.

Mr. Moss reported that swirl could be stopped by a single diaphragm in the fan inlet, according to experience with some high-speed fans. In his opinion, the means for straightening flow should be part of the fan.

PULSATING AIR FLOW

MECHANICALLY induced air flow is pulsating even when it may seem steady. This pulsation causes errors in velocity measurements often as great as 20 per cent when the conventional pitot or orifice is used with a liquid manometer, and it causes an increase in the velocity energy and fluid friction loss that can easily reach 50 per cent. Velocity head is proportional to the square of the velocity. Since a manometer indicates the average value of this pressure, a velocity calculated from such readings is the square root of the average value of the squared velocities, thus is in error.

In "Pulsating Air Flow," N. P. Bailey describes a simple portable instrument which he has developed for measuring the true average air velocity regardless of pulsation. In this instrument the velocity head of the air is used to cause water to flow through an orifice. Since the velocity head of the air flow varies as the square of the air velocity, and the rate of flow of water to an orifice varies as the square root of the applied head, it follows that at any instant the rate of flow of water through the orifice is directly proportional to the air velocity at that instant. The water flowing through the orifice is collected for a given period, and the average rate of flow determined. From this the average air velocity can be found. The instrument was first verified by checking it on a velocity wave form of known characteristics. A blower was then tested for several conditions of operation, and the air velocity determined with the instrument compared with values given by the conventional instrument.

Plans are under way to adapt this instrument for measuring pulsating flow of water and other fluids.

Discussion

MUCH interest was expressed on the record of operating the instrument, particularly as regards the technique involved. Mr. Moss pointed out that it seemed to him the instrument would be usable not only with a pitot tube, but with nozzles or thin-plate orifices. To eliminate errors due to connecting tubing, he suggested filling the connections with water and placing the manometer tubes as close to the work as possible. Professor Marks expressed the belief that the instrument would be useful for low-pressure and low-frequency work, but not with the pulsation frequencies, such as with fans.

In closing his paper, Mr. Bailey pointed out that most of the pulsations were damped out, and the flow of water was relatively steady.

INTAKE ORIFICE FOR TESTING EXHAUST FANS

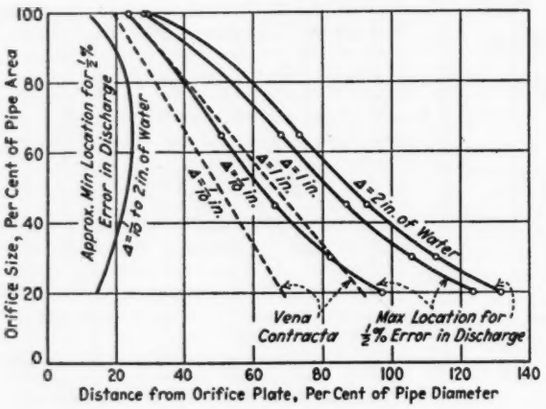
THE Test Code method of determining characteristics of exhaust fans, particularly of the propeller type, takes a lot of equipment and time. M. C. Ebaugh and R. Whitfield believed that the thin-plate orifice might be simpler and accurate enough for measuring air flow, so mounted one on the intake end of a pipe. In "Intake Orifices and Proposed Method for Testing Exhaust Fans" they describe tests covering the range of low differential pressures of 0.1 to 2 in. of water.

Tests covered five sizes of orifices from 20 per cent to full pipe area. Air was drawn through the test equipment by a fan with 25-in. impeller running at 700 r.p.m. Orifices were placed at the end of a 22-ft. 2-in. length of 22.75-in. pipe, followed by a Venturi meter and an elbow discharging into the fan inlet. The Venturi

was calibrated by a special method described in an appendix to the paper which also described calibration of the manometers.

Variation of pressure upstream from the orifice, shift of the vena contracta with size and differential pressure, and coefficient of discharge were recorded. Micromanometers giving a direct reading to 0.001 in. measured pressure upstream at 17 taps 2 in. apart.

Tests results indicate that the intake orifice is satisfactory for metering differential pressures as low as 0.05 in. of water. Although the vena contracta shifts with changes in orifice size and differential pressure, a single-pressure tap 0.40 pipe diameters downstream from the orifice may be used with orifices of 20 to 80 per cent pipe area and for differential pressures above 0.1 in. of water with a coefficient of discharge of 0.601.


Orifice Size, Per Cent of Pipe Area
Distance from Orifice Plate, Per Cent of Pipe Diameter
Approx. Min Location for ½% Error in Discharge
Δ=½ to 2 in. of Water
Δ=⅛ in.
Δ=¼ in.
Δ=1 in.
Δ=2 in. of Water
Vena Contracta
Max Location for ½% Error in Discharge

Discussion

MR. SPRENKLE disclosed that there had been some recent German work along the same line as that of Professor Ebaugh, and that this work was in substantial agreement with the results reported in Professor Ebaugh's paper.

FAN TEST CODE

M. C. STUART in his report, "Status of Test Code for Fans," explained that items required to be reported in the test of a fan include, (a) quantity of air discharged; (b) "head" against which the fan operates; (c) power required; (d) efficiency; (e) speed; and (f) temperature and density of air handled. Of these, the only ones which present any real difficulty of measurement or uncertainty as to method of specifying are the first two.

There are many methods available for measuring air flow which are of undisputed accuracy when used under certain ideal conditions which may be easily specified, and reproduced with more or less ease. In the flow of air to or from fans there exist, however, serious departures from the ideal conditions for accuracy of the several available methods of measurement. Further, for code requirements, a method must be not only accurate, but practical and economical in its application.

Guide for locating pressure taps for various differentials and orifice sizes

Two general methods of attack on the problem are possible. We may codify these methods which are practical and of established accuracy under the conditions of flow existing. Another economic solution may be to modify the flow conditions to bring a feasible method within a range of desired accuracy.

It is planned that in revision of the code the accuracy and practicability of points in question shall be established upon a basis of research conducted for the purpose.

FAN RESEARCH PROGRESS

THE "Progress Report on Fan Research at Lehigh University," presented by W. E. Somers, contains the results of investigations carried out under auspices of the subcommittee on the Fan Test Code up to the time of the 1934 A.S.M.E. Annual Meeting, and outlines further investigations planned. These investigations were suggested by various members of the committee. The work accomplished includes an investigation of the effect of fan speed on the difference between discharge measured by pitot tube and by nozzle. These results were first reported at the subcommittee meeting at Buck Hill Falls last June.

Further investigation of orifice characteristics is planned in an attempt to establish the conditions for reliability of the orifice for air-flow measurement in fan testing. It is planned to demonstrate any proposed code with various types of fans under practical conditions.

EFFECT OF OUTLET BEND ON FAN PERFORMANCE

FOLLOWING up the work showing the influence of inlet boxes and inlet ducts on performance of centrifugal fans, L. S. Marks reported work undertaken to determine the effect of bends or obstructions at the fan discharge outlet on fan performance. His paper described tests made to determine the influence on fan performance of a 90-deg. bend in the fan discharge and also the effect of fans discharging into a T duct of considerably larger cross-section.

From the tests made the authors concluded that operation of the fan tested was not affected to any appreciable extent by sudden enlargements or change of direction of the air stream as it left the fan housing. This conclusion may be applied quite generally whenever the fan housing is sufficiently complete to give the discharge air a general direction of flow and a uniform distribution at the outlet.

CHEAPER AND STRONGER MACHINES THROUGH

APPLIED MECHANICS

FOR years the Applied Mechanics Division has fostered a mass of work, sometimes experimental, sometimes highly analytical, sometimes both. Most of these papers have, however, had definite practical objectives: better designed machines and equipment at lower cost; the good designer must get endurance without wasting any material.

He must always remember that no chain is stronger than its weakest link. His first job is to make the weakest link strong enough and his second to avoid giving unnecessary and unknown strength to other links at higher cost. His ideal, in short, must be the "one-hoss shay."

Two papers presented by the Applied Mechanics Division brought reality closer to this ideal.

COVER PLATES AND FLANGES

SIMPLE shells are easy to figure for stress. Unfortunately, shells of pipes and pressure vessels are rarely simple because the engineer insists on cutting holes in them and then trying to reinforce the holes. Result: something almost impossible to figure—links too strong for economy or too weak for comfort. The "Strength and Design of Covers and Flanges for Vessel Openings" were studied in a practical way by T. McLean Jasper, Herman Gregersen and A. M. Zoellner of A. O. Smith Corp. They found the wrong formulas commonly used and the right formulas wrongly applied—in general a bad state of affairs. Next they made their own rings and hubbed flanges, tested them and tested the formulas against the physical tests. Result: more reliable dope for designers on proportions, fillets, etc.

SOLAR PLEXUS OF SHAFTS

THE "weak link" in a shaft is often the place where it is shrink- or press-fitted into a flywheel, turbine rotor or other member. Just outside the fit, to be precise, just as with an overhanging bar clamped in a vise and bent back and forth, fatigue hits outside the jaw, but close to its edge.

R. E. Peterson and A. M. Wahl of Westinghouse went after this problem, surveyed the history of failures, tested fitted shafts in their own laboratories, made stress and photo-electric analyses.

FLUID METERS

CALIBRATION TESTS ON WEIRS AND ORIFICES

GEOMETRICAL and flow similarity in a weir are usually accompanied by identical coefficients, regardless of size and, in this case, head. V-notch weirs are similar in shape for all heads, since cross-section remains a similar triangle, regardless of head. For theoretically complete similarity, dimensions of the weir should be changed in proportion to head, according to Ed. S. Smith, in "The V-Notch Weir for Hot Water." Since this is generally impractical, their effects are generally minimized by reducing velocity of approach to a negligible amount, by having the weir-notch vertex over three times the head from the floor and sides of the weir box, and by providing baffling to produce a fairly uniform velocity of approach.

The nearest baffle should be at least four times, and preferably ten times, the head from the weir plate. Head should be measured at a point slightly downstream from this baffle. The weir edge should be sharp, square and about $\frac{1}{32}$ in. thick, and the trailing edge should have about 60 deg. clearance to facilitate aeration and clear the liquid away.

During an investigation of heat transfer at Dunbar Laboratory of Harvard Engineering School, it was necessary to calibrate rounded approach orifices for oil and for water. Three with throat diameters of 0.5035 in., 0.250 in. and 0.1250 in. were tested with oil. A similar orifice 0.250 in. in diameter was tested with water. Results were given in "Calibration of Rounded Approach Orifices," by J. F. Downie Smith. The orifice coefficient, obtained from $V = c\sqrt{2\ gh}$, was plotted against Reynolds, number R for the straight section of the orifice.

For the two medium-sized orifices (one for oil and one for water) the two curves relating to c and R were continuous, as would be expected from dimensional considerations. Coefficients for the large oil orifice were about 0.5 per cent higher than those of the medium-sized orifice of the same Reynolds' number.

An interesting characteristic of the medium-sized oil-orifice calibration curve is a loop in its critical region, as determined by R at the straight section of the orifice. This section of the curve should be avoided where accurate coefficients are desired. Since medium-sized orifices for both water and oil give the same curve, it is reasonable to expect that this holds for similar orifices for other liquids with properties not too far removed.

"THE ROOT OF ALL EVIL"—
BOILER FEEDWATER

LIKE THAT of medicine the science of boiler feedwater treatment and conditioning is important and endless. In the search for dollar-saving water facts many thousands of dollars and untold time have been expended on researches under the auspices of the Boiler Feedwater Studies Committees, of which Sheppard T. Powell is chairman. Results previously reported have been well worth the cost in reduced outage and maintenance and increased efficiency of power-plant boilers. Additional progress was revealed in the two feed-water sessions this year.

NAVY LIKES 1933 COMPOUND

POWER for Mid-December, 1933 (page 687), announced the U. S. Navy's tentative standardization on a new boiler compound ("Navy Compound 1933"). Its formula was selected after extensive operating tests costing thousands of dollars. The constituents of this compound are:

Anhydrous disodium phosphate..47 per cent
Soda Ash .....44 per cent
Corn starch ..... 9 per cent

This has now been given an extensive trial in fifty ships of the fleet. Results as presented by Dr. Robert C. Adams, Jr., chemical engineer, U. S. Naval Experiment Station, Annapolis, Md., are distinctly favorable. Over two-thirds of the ships reported no clouding of gage glasses. Practically all said there was no tendency to prime. Most of the ships reported a decrease in corrosion and only one an increase. Commenting on his paper ("Results from the Change in the Navy's Method of Boiler Water Treatment") Dr. Adams again warned against its indiscriminate application to land plants or merchant marine. On Navy ships, the character of impurities is fairly constant and notably different from that of most land plants.

DOES SULPHITE KILL OXYGEN?

FOR years dissolved oxygen has been recognized as a primary cause of corrosion. Today much money is spent to get it out of feed water, and keep it out. To get it out, mechanical deaeration has generally been used. Special deaerators or deaerating heaters "boil off" the air and pass it off with the vented vapor. But, it is well known that certain chemicals combine with dissolved oxygen. Some of these, notably sodium sulphite, have been considerably used for this purpose in the past year or two.

Discussion

Dr. R. E. Hall (Hall Labs., Inc.) reported several years of operation of the boiler plant of the Pittsburgh Steel Co., Monessen, Pa. Monongahela River water is dosed with a special sulphite mixture and then fed directly to 400-lb. boilers with no evidences of corrosion.

The importance of getting the correct grade of sulphite was stressed by several speakers. Some suggested using proprietary brands to insure correct quality. Others strongly urged the preparation of complete specifications that could be handed to purchasing agents for competitive price buying.

One speaker said that purchasing agents could get engineers what they need if engineers will be more specific in requests.

S. P. Applebaum, Permutit Corp., referred to cases of economizer corrosion where sulphite was used and suggested that inserting a tank in the line to give ample reaction time might eliminate this trouble. There was no corrosion in the boiler concerned.

E. H. Barry, power supervisor of West Virginia Pulp & Paper Co., said he had gotten excellent deaeration with ordinary open heaters vented liberally. The resulting water had been satisfactory for all boiler pressures from 45 to 600 lb. Certain cases of economizer corrosion led him to suspect that stagnant water (due to poor circulation) is much more likely to cause corrosion.

Mr. Powell warned against attempts to use sulphite as the sole means of removing oxygen. Mechanical deaeration should always come first, he said, leaving sulphite, if used, to remove the last traces only.

Another discussion developed on the use of tannin for boiler dosing. Many comments were favorable. Several speakers reported use of tannin for long periods without tube failures or traces of corrosion. Captain Dinger reported experiences with a number of marine boilers where tube loss had stopped as soon as tannin treatment was started.

WAR ON EMBRITTLEMENT

IN ANOTHER feed-water session was presented "A Critical Summary of Published Information Relating to the Embrittlement of Boiler Steel." This is part of a survey made in cooperation with the Bureau of Mines. Results have not yet been released for publication.

Two other research papers of specialized interest were "The Solubility of Sodium Sulphate in Boiler Water Salines As Related to the Prevention of Embrittlement," and "The Effect of Solution Concentration on the Failure of Highly Stressed Steel," both reports by W. C. Schroeder and E. P. Partridge.

THEORY AND PRACTICE COINCIDE IN

LUBRICATION

Tests on journal bearings show performance can be accurately predicted by theory. Experience shows danger of high-speed bearings failing at low speeds is over-rated

EFFECTS OF SIDE LEAKAGE IN JOURNAL BEARINGS

THEORETICAL treatment of journal bearing lubrication, based on an infinitely wide bearing (hence no oil flow from the film sides) has been highly developed. Less is known, however, of phenomena that occur in an actual oil film. Experiments necessary on a bearing of finite proportions and from which oil is leaking at the film sides show results entirely different from those predicted by theory which takes no account of side leakage.

By an indirect method of electrical integration, Sidney J. Needs undertook an analysis of the problem as applied to a 120-deg. centrally supported bearing, the results of which were presented in "Effects of Side Leakage in 120-deg. Centrally Supported Journal Bearings." Effects of side leakage are found to vary not only with bearing length and width, but also with load. Results are given in tabular form and also by curves, and from these, best operating conditions are apparent.

JOURNAL BEARING TESTS

ALTHOUGH the hydrodynamical theory of lubrication was developed long ago, design of modern bearings is still based largely on empirical data. Theoretical developments treat an ideal bearing never realized in practice. Even for this ideal bearing the calculations are complicated, particularly for journal bearings. Deformation of the bearing by loads and temperature stresses, accuracy of machining and degree of finish are factors which cannot be easily introduced in theoretical consideration. For these reasons, improvements in bearing designs can be made only after data are obtained from tests duplicating as much as possible normal operating and manufacturing conditions.

Tests made on journal bearings by Westinghouse were the subject of "Performance of Large Journal Bearings" by R. Baudry and L. M. Tichvinsky. These showed rather close agreement with theoretical results made available in recent years. Laboratory tests for determining maximum carrying capacity and coefficient of friction for various speeds were made using a standard 6-in. x 12-in. stock journal bearing. Tests also were made under normal operations of a 30x60-in. bearing which was part of a 60,000-kva. generator.

Bearing performance can be calculated from the characteristic number $\frac{ZN}{P}$, where Z equals viscosity in centipoises (depending upon temperature and grade of oil), N speed in revolutions per minute, and P unit pressure of projected area in pounds per square inch. Coefficient of friction and minimum oil-film thickness of a journal bearing are shown to be nearly independent of variations of unit clearance between rather wide limits during which the bearing operates near the best condition of minimum coefficient of friction and maximum oil-film thickness. The calculation of bearing performance is thus made easy.

LARGE BEARINGS

AN ACCURATE experimental investigation of sleeve-bearing oil films on a large-size power bearing was described in "Film Lubrication in Sleeve Bearings," by M. Stone. Results of this investigation show a sufficiently close agreement of theory and practice to allow designers to make minimum oil-film thickness a reliable criterion of bearing performance. This can be considered as a refutation of Wolff's results, using an interferometric method, subject to definite objects.

OIL-FILM BEARINGS

"CURRENT Practice in Pressure, Speed, Clearances, and Lubrication of Oil Film Bearings," by H. A. S. Howarth, contains much design and operating data furnished by makers of bearings for the trade and for machinery of their own manufacture. Most of the data are tabulated and classified on charts, the most useful of which has as its coordinates pressure and velocity. Upon this chart are applied special scales showing some of Dr. Albert Kingsbury's "Optimum Conditions for Journal Bearings." Examples show how analytical laws are useful in solving simple, practical problems of bearing design.

Selection of a lubricant of suitable viscosity is explained by a chart that may be entered with calculated absolute-viscosity coefficient at operating temperature, and will yield the required commercial viscosity in Saybolt or Redwood seconds or Engler number for a mineral oil of any base.

Discussion

EXPERIENCES related when presenting and discussing these papers clearly indicated that the art of designing and lubricating journal bearings has been developed until theory and practice agree quite closely. Performance of bearings and their lubrication can now be predicted with a high degree of certainty. If bearings are operated under conditions for which they are designed, long life and satisfactory service can be expected.

It was pointed out that the load carried by a bearing depended upon the ratio of its length to its width. Loads of over 10,000 lb. per sq.in. have been carried on journal bearings before failure of the oil film and bearing.

Operation of bearings at slow journal speeds was the subject of considerable attention. From this discussion it was evident that some of the fear of heavily loaded high-speed bearings failing when operating at slow speed, such as when stopping and starting, is not well founded. Some of these bearings have been operated at 1 r.p.m. without injury. Even if only a partial oil film is maintained, the journal is moving so slowly that if metal-to-metal contact should occur sufficient heat would not be produced to damage the bearing. Kingsbury thrust bearings will operate at speeds as low as 5 to 1 r.p.m. before there is any indication of oil-film failure. In one case a bearing having a mean diameter of 9 in. was operated heavily loaded at speed of less than 1 r.p.m. for a considerable period.

Tests have shown that the oil-film thickness between a journal, running at normal speed, and its bearing varies through a cycle so that a point on the end of the shaft describes a closed figure. Electrical gages have been developed that are mounted on the bearing and make possible measuring shaft movement of one-millionth of an inch.

The necessity of maintaining good alignment of bearings was emphasized. If bearings are not in good alignment with their journals, in some part of the bearing the oil film may be thick and in others it will be very thin or even ruptured. Bearings may be properly aligned on the bedplate before the rotor is in place, but because of bearing pedestals and bedplate distortion, due to the rotor weight or to other causes, the bearings may be out of line after the machine is assembled.

Tests made on a Kingsbury type thrust bearing showed that higher loading pressures could be carried on babbit metal than on bronze. In one case where a bearing of this type was loaded to destruction, bronze failed at loads of about 14,000 lb. per sq.in. and babbit-faced shoes carries over 16,000 lb. per sq.in. before failure.

In answer to a proposal that when laboratory tests were made care should be taken to duplicate practical conditions in oil and other factors, it was suggested that laboratory conditions be duplicated in practice. Bearings can be designed to carry heavy unit loads, operate efficiently and have long life. To do this, however, they must be supplied with clean oil of the proper grade and advantage taken of means available for keeping the lubricant in good condition. Laboratory conditions must go into operation of bearings if they are to operate successfully under loads carried in the laboratory.

OPERATING EXPERIENCE WITH

COAL FIRING

Data on stoker maintenance with preheated air discussed, and operation at most recent central stations reported at sessions on firing. New method of comparing grindability of coals presented

FUEL BURNING AT BUZZARD POINT

BUZZARD POINT power station of Potomac Electric Power Co. exemplifies the latest trend in power station design, steam conditions being 650 lb., 850 deg. Experience with the unit system of pulverized coal there was reported by H. G. Thielscher.

Furnaces are completely water cooled with slag tap bottoms. 37,000 B.t.u. heat release in furnace at full load gives excellent results. Combustible in fly ash averages 12 per cent and oversize electrostatic precipators recover practically all fly ash.

Pulverizers show sustained fineness after grinding 25,000 tons of coal without replacement of wearing parts. Slag tapping has been accomplished with a minimum of labor. Unit system has shown a practical working range of 7 to 1.

Method of controlling steam temperature gives flat superheat curve from 55 per cent boiler load up to 100 per cent. Monthly operating efficiencies of unit are close to test guarantees, showing ability to control combustion and operation closely.

Over-all plant performance was 12,672 B.t.u. per net kw.-hr. for the six months January to June, during the period of preliminary operation.

Discussion

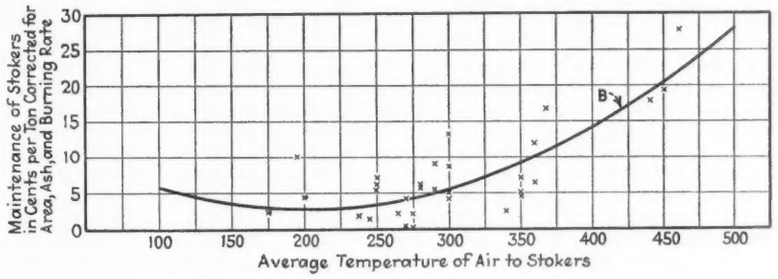
PROFESSOR CHRISTIE remarked on the use of hydraulic couplings on induced-draft fans and that it was his understanding that these couplings had been slow in responding to control. He also understood that there had been difficulty with the horizontal tubes in the air preheater, that there had been considerable secondary combustion in the space between the dust screen and the boiler tubes, and wondered why this screen had been located so far from the boiler tubes. E. G. Bailey replied to this latter inquiry by saying that the screen should actually be closer to the furnace floor. Mr. Hopping of Philadelphia remarked that the lack of response in hydraulic couplings had been overcome and these couplings were being ordered for the new unit at Richmond Station.

EFFECT OF HOT AIR ON STOKER MAINTENANCE

EXPERIENCE has shown that highly preheated air has increased the maintenance of underfeed stokers beyond reasonable figures. To select air preheaters intelligently, the engineer must know to just what extent stoker maintenance is a function of air temperature. The result of an investigation of this relationship was reported in "Economics of Preheated Air for Stokers," by R. E. Dillon and M. D. Engle.

For this purpose, data was obtained from 33 companies operating 122 underfeed stokers supplied with hot air varying from 120 to 460 deg., maximum air temperature as high as 600 deg., and representing 475 stoker years of operation.

From this data it was found that the variables, other than average air temperature, that most seriously affect maintenance are, area of stoker, average coal burned in pounds per square foot per hour, and percentage of ash in coal burned. The data were corrected for these three variables, and a new curve of maintenance plotted against air temperature, from which some of the influence of these variables was removed.



Maintenance of stokers vs. average air temperature

From this corrected curve it was concluded that up to 300 deg. the preheating of the air supplied to the underfeed stokers does not seem to increase maintenance above reasonable figures, but above 300 or 350 deg. there is a sharp increase in maintenance with increase in air temperature.

Discussion

J. VANBRUNT expressed surprise that the curves of stoker maintenance showed higher cost with 75 deg. air than with air at 200 deg. He also believed that size of stoker alone should not affect maintenance to the extent shown, and that maintenance should be lower as excess air increases instead of as shown by the author. I. E. Moultrop deplored the apparent indications of a limit in temperature for preheated air and urged manufacturers to do research work leading to the development of stokers that would make possible higher air temperatures. J. W. Armour reported that his company had been doing research on the use of alloy cast irons for use in stokers with high air preheat temperatures, but could not yet predict economic use of any so far investigated. Mr. Bennett disclosed that there had been in operation three water-cooled stokers and that a fourth is to be installed using 400 deg. air.

RELATIVE GRINDABILITY OF COAL

COAL pulverizers have varying capacities with different grades of coal, and to predict performance it is necessary to know something about the grindability of the coal. Several methods of determining the relative grindability of coals have been advanced, and in "Relative Grindability of Coal," H. J. Sloman and A. C. Barnhart propose a roll test method which they believe simpler to operate, easier to control, and with which results may be duplicated. The test is based on principle of increase of new surface measured in accordance with Rittinger's theory of crushing. In this test, which the authors call the C.I.T. roll test, 20 grams of a sized sample of coal are spread over an area 5x4 in. and subjected to the crushing action of a cylinder which is rolled over the coal ten times. The cylinder is 8.5 in. in diameter, 7 in. long, and weighs 105 lb.

Twenty-nine representative bituminous coal samples were tested and their relative grindability determined by this method. Many of the values have been correlated with those obtained by the Fuels Research Laboratory of Canada, method, the Hardgrove method and the Cross method. An important phase of this paper is the discussion of particle size determination by the sedimentation velocity method. The particle size distribution of coal passing through a 300-mesh screen has been studied experimentally and a more rational value for the factor used in determining the surface of coal passing through the 300-mesh screen is proposed.

Discussion

CURVES were shown comparing the F.R.L method and the C.I.T. methods of determining grindability which showed that the C.I.T. method gives results that apparently lie on two curves, one high and one low. Mr. Engle deplored the number of methods for determining grindability and hoped that some agency would establish one of these as a standard. It was disclosed that this work is now being done by the A.S.T.M.

DESIGNER AND OPERATOR VIEW THE PROBLEM:

WELDING vs. CASTING

Welded structural shapes, welded piping, welded pressure vessels—these fairly young processes grow like mushrooms into casting-minded conservatism. Here is a debate on respective merits of the old and the new

For the last few years, proponents of that lusty young infant, welding, have been itching for a real argument on welding vs. casting. Their success against riveting and bolting has been notable, but somnolent foundrymen have suddenly awakened and gone to work to better their products. The result is better castings to compete or cooperate with better welding, in any case giving the power engineer stronger and better products capable of standing higher stresses, higher pressures, higher temperatures.

STEEL VS. CAST IRON

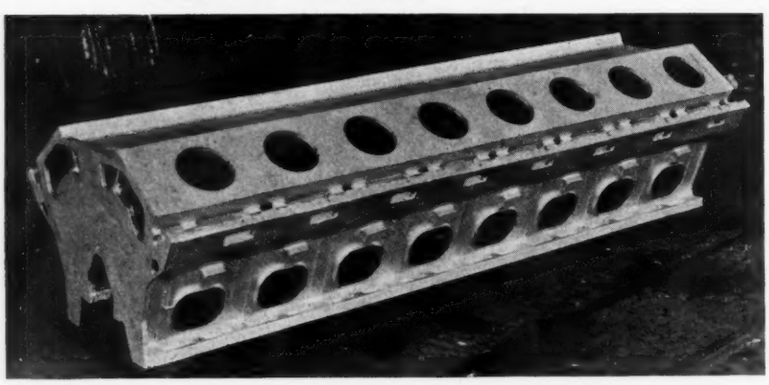
An extensive comparison of properties was presented in "Steel and Cast Iron in Stress-Transmitting Mechanisms," by Everett Chapman. General conclusions were that commercial gray iron is an aggregate of pure graphite in flake form and impure steel, the graphite flakes supporting the matrix in compression but starting incipient cracks in tension or torsion. Welded steel, on the contrary, is 2½ times stiffer and excellent in tension and torsion as well as compression, providing *welds are properly made.* Cast iron "grows" much more than steel under repeated heating and cooling.

Modern weld metal is a freak. It is perfectly possible to produce in the electric arc, in the form of weld metal, a steel with carbon content of 0.08%, tensile strength of 65,000 lb. per sq.in., and elongation 35% in 2 in., much better than anything producible by the open-hearth process. But, to carry the analogy further, the latent tensile strength of open-hearth steel is about 500,000 lb. per sq.in., while the usual values in practice are about a tenth of that figure. In other words, man has not yet learned to process steel to obtain its maximum properties.

Among Mr. Chapman's illustrations of newer power units designed for steel is the engine frame illustrated. This is completely welded up from plates and combines light weight with the ability to sustain high impact loading for long periods of time. The gas load of 38,000 lb. is applied at the bolt circle holding the cylinder head to the top deck, and the reaction to the gas load occurs at the large studs that secure the main bearing cap to the frame. V-type construction further complicates the loading, since a joint must be put in between two elements in tension.

Cromansil steel with flame-cut contours provides the necessary strength and avoids sharp (and weak) corners. Machining also was used in order to produce a generous curve at the point of intersection of the top deck and the side sheets. It is sound practice in a structure of this character definitely to control these critical sections, and welding in general cannot be relied upon to produce a predictable contour in a corner. A careful technique must be specified and supervised in making the joints between the component parts in order further to insure the absence of uncontrolled boundaries, either internal or external. Once this procedure has been followed, the only limit to the lowering of the factor of safety is the residual uncertainty as to how far this process has been carried, not only in the construction of the piece but also in the actual selection of the steel entering into the structure. In the ultimate, then, the strength of a structure could increase indefinitely in proportion to the cleanliness of the materials and cleanliness of the design.

V-type diesel frame, welded of cromansil steel



CASTING VS. WELDING—BY A USER

S. Einstein, chief engineer of Cincinnati Milling Machine Co. and Cincinnati Grinders, Inc., discussed the subject from the user's point of view. Whether a cast or welded structure is to be used for machines or machine parts depends on many factors. The average machine shop has very little or no experience in welding. The majority of designers, if asked to design a welded structure, incorporate in it the experiences and ideas which they had on cast iron. Thus advantages of the welded structure are greatly minimized.

Welded structures in general are lighter in weight, have greater strength proportional to their weight, enable quicker delivery, and result frequently in more stable structures. Theoretically, the cost of such parts, if only made singly, is cheaper; and under certain conditions the cost of parts manufactured in very large quantities with elaborate tooling might be cheaper. Cost of patterns is eliminated for welded structures, but the necessity for templates or other auxiliary tools reduces this saving.

The disadvantage of welded structures is the greater possibility of vibrations—the cast structure dampens vibration, while the welded structure may resonate. The welded structure on a medium-size production job results in higher cost, and this is particularly so when cast iron or hardened steel ways have to be attached to such a structure for sliding surfaces. To reduce internal strains, welded structures quite often have to be annealed, a further item of expense. The welded structure does not lend itself so readily to production of pleasing lines and contours. Generally speaking, the best and cheapest welded structure is the structure which has a minimum of welded joints.

Mr. Einstein's company normally welds designs of which only one unit is required, considers the merits of both casting and welding when 3 to 5 units are required, and above that number uses castings.

Discussion

Mr. Horgan of General Electric brought out in discussion that the rapid ascendance of welding has put the foundryman on his mettle, after years of slumbering security, the result being better products for the user. Other discussers brought out present high costs of welded construction, the tendency toward greater vibration with steel, the fact that steel castings and rolled steel are now being combined by welding.

THEY DID GET AROUND TO

INDUSTRIAL POWER

"Industrial Power" session contained no papers specifically serving industrial power men. Their innings came later at their private conference luncheon

To be perfectly frank, industrial power engineers are generally disappointed at the small number of A.S.M.E. Annual Meeting papers devoted to their particular problems. This year that percentage was zero; not one of the 100 papers presented dealt specifically with the industrial plant. True, scores of papers were applicable to all classes of power plants, *including* industrials. Most of the papers in the Central Station sessions offered much of value to industrial power men, particularly operators of large plants.

Nevertheless there was nothing *for* them specifically. Note the program of the so-called "industrial power" session: A paper on fan tests and another on forced distribution in once-through steam generators.

In spite of any impression to the contrary, the blame for this condition must be laid at the door of the industrial power engineers themselves. Many were invited to give papers, but none, for lack of time or other reasons, would deliver.

The picture has perhaps been painted a little too black, because the industrial power engineers did finally get their innings, even though they were unofficial and off the main A.S.M.E. lot. As in several previous years, the Industrial Power Conference met at the Fraternity Clubs building for luncheon and a worth-while industrial program. This group, while not officially a part of the A.S.M.E., is made up almost entirely of A.S.M.E. members actively engaged as industrial power engineers.

Before reporting this luncheon meeting the papers of the official "Industrial Power" session should be reviewed briefly. It should be made clear that the foregoing comments are no reflection on these papers; their authors merely found themselves placed in this particular program.

FORCED-CIRCULATION BOILERS

Several years ago Purdue University experimenters reported tests on a once-through 3,200-lb. pressure boiler (Benson principle) in the Purdue laboratories. In "Flow Distribution in Forced-Circulation Boilers," H. L. Solberg, G. A. Hawkins and A. A. Potter reported the inequalities of flow through the parallel water circuits of this boiler and its effect on heat absorption. Among the more important conclusions was this: "The use of a common header or equalizer on each side of the evaporating zone will stabilize the flow in parallel circuits."

BENDS IN FAN OUTLETS

In "Influence of Bends or Obstructions at the Fan Discharge Outlet on the Performance of Centrifugal Fans," Prof. Lional Marks of Harvard concluded that such influence is practically nil where the fan itself has a proper casing. He made clear, of course, that the obstruction increases the resistance against which the fan must work, although this does not affect the performance of the fan *itself*. Practically, then, it makes no difference whether the obstruction is close to the fan discharge or far away. In the discussion some hinted that this might not hold true in the case of incompletely housed fans and of propeller-type fans.

PLANT ENGINEERS EAT AND TALK

The luncheon already mentioned was an enjoyable affair socially, and profitable in terms of engineering knowledge exchange. David Moffat Myers, chairman of the group, presided. He presented evidence that the "power, heat and light" cost of industry in 1934 was approximately equal to its net earnings. Thus, he said, a saving of 30 cents on the power dollar today would add 30 per cent to the net earnings of American industry.

Reports were read by two committees. The Power Cost and Record Committee presented tentative forms for the exchange of operating data among plants. The Power Plant Betterment Committee submitted as its report an elaborate chart of power plant losses, previously prepared and published by David Moffat Meyers (chairman) and N. C. Artsay.

F. M. Gibson, plant negineer of American Sugar Refining Co., Brooklyn, N.Y., was elected chairman of the Industrial Power Conference for the coming year, succeeding Mr. Myers.

VELOX BOILER

The rest of the meeting was devoted to a paper on the Velox boiler by Paul R. Sidler of the Brown, Boveri Co. This radical unit has been used abroad for several years and has been described in the foreign and American technical press. Its details are, however, still unfamiliar to many American engineers. The unit, which can be delivered complete and set up for operation in two or three days, includes an "evaporator" where combustion takes place under a pressure of about 40 lb. per sq. in. The exhaust gases leave the evaporator with enough pressure to drive a gas turbine which, in turn, drives the turbine-compressor for combustion air. A motor, mounted on the same shaft, supplies additional power, where needed.

Many other points are of great interest. Gas velocities in the Velox boiler run from 450 to 900 ft. a sec., and the "evaporator" cools the gases just enough to protect the gas turbine. Leaving the gas turbine the gases pass to an economizer. The Velox boiler contains an extremely small quantity of steam and water, and very little metal, hence may be started from cold in a few minutes. The combination of high-pressure combustion and enormous gas speeds produces combustion rates and heat-transfer rates unheard of in ordinary boiler practice, for example, heat releases approaching 1,000,000 B.t.u.

Circulation is artificially maintained by a pump which circulates water at approximately ten times the steaming rate. The mixture of steam and water leaving the evaporator is delivered to a centrifugal separator, and the resulting reasonably dry steam is fed to the superheater.

At present only gas and oil can be used as fuels. The gas turbine has an over-all efficiency ratio of 60 per cent; its casing is entirely welded. Governing of the entire unit is automatic and operates with sufficient speed to prevent blowing off if boiler load is suddenly dropped.

According to Mr. Sidler, the following results were obtained on a test:

25,000 lb. of steam per hour were generated at 400 lb. pressure and 750 deg., burning fuel oil. Heat release rate reached 890,000 B.t.u. per cu. ft., and evaporation 101.5 lb. of steam per sq. ft. of evaporator heating surface. The over-all efficiency, including auxiliaries, reached 92 per cent, based on the lower heat value (the usual European practice) or 87 per cent on the higher heat value. Enormous reductions in weight and space requirements were shown as reasons for installing this type of unit in ships, particularly. Overall cost of the unit was said to be 5 to 8 per cent higher than that of an ordinary boiler plant, but this excess is offset by savings in cost of buildings. Units are now available for all pressures up to 600 lb.

Discussion

Wm. Shoudy, consulting engineer, looked ahead to the day when steam-generating units will be bought "off the shelf," and expressed great interest in the unit described, particularly because of its compactness. Mr. Artsay said that he was extremely impressed with the design, but doubted whether it could be satisfactorily adapted to powdered coal. One other limitation of the Velox boiler, said Mr. Artsay, is its inability to operate at less than 10 per cent of capacity. With this unit it has been possible to consume 15,000 lb. of oil per hr. through a single burner, he pointed out.

DEPRESSION YEARS GIVE IMPETUS TO

DIESEL PROGRESS

Hirshfeld's capable Power Progress Report shows diesel power making spectacular gains, with principal development in small units. Oil & Gas Power session includes but one paper and a discussion

MUCH hope for the future of the diesel engine was given in the combined Power Progress Report (replacing individual Division reports for the first time this year) by C. F. Hirshfeld, chief of research, Detroit Edison Co. While bad economic conditions have meant fewer power projects generally, the diesel industry has developed in "almost spectacular style." This is due to increased rotative speeds (giving lighter or more powerful engines), increasing use of superchargers, improved design and materials (meaning better performance and less maintenance), and to solid injection (meaning simplified installations). Greatest fields today for the diesel are in transportation and in the small or comparatively small stationary plant, where the greater simplicity and higher thermal efficiency of the diesel shows to greatest advantage. Utility companies are beginning to see the merits of the diesel for small isolated plants to avoid long, expensive transmission lines. But Dr. Hirshfeld injected the note of warning that a future important competitor of the diesel will be the small, single-unit, high-pressure and high-temperature steam plant. Though its thermal efficiency is lower, its economic efficiency (the efficiency which *sells* prime movers) may be higher due to cheaper fuel.

Dr. Hirshfeld also mentioned use of alloy cast iron for crankshafts in automotive engines and high-speed diesels.

MOTORSHIP'S FUTURE

LOUIS R. FORD, in "Future of the Motorship in the United States," outlines an anomalous situation in which the United States is found to be the only maritime nation that has thus far clung to steam machinery exclusively for propulsion of its large, seagoing merchant ships. So extensively has the diesel engine been applied to all forms of marine propulsion in foreign countries that now 58.3 per cent of all tonnage building throughout the world is equipped with diesel machinery. Of the total motorship tonnage under construction throughout the world the United States is building but 0.9 of 1 per cent.

The imminence of a cargo ship building program in the United States, as forecast by President Roosevelt's positive statement that subsidy legislation will be enacted by the next Congress, suggests the advisability of an analysis of the situation, with a view to determining what are the factors that have influenced American shipowners to prefer steam to diesel machinery.

Discussion

MR. HUCKLE brought out that the new Thomas-Richotte system of producing full-automatic diesel sets using several small engines (described recently in *Power* by Mr. Thomas) is now on trial in an installation for a Nevada "dude" ranch, and that another installation, using three Ford V-8 engines, is soon to be tested. If successful, an installation of three diesels will be tested on a fishing boat.

Fuel Standardization

DR. P. H. SCHWEITZER of Penn State College led discussion on this point, reporting failure of the combined A.S.M.E.-S.A.E. Fuel Oil Standardization Committee, and announcing the recently proposed A.S.T.M. tentative standard. He advocated conciliation and cooperation in settlement of this important problem.

Discussion

SEVERAL discussers brought out that they were at present using fuels that fall between two of the grades shown in the A.S.T.M. tentative standards, and that in certain cases the gaps are too wide betwen grades. It was the opinion of discussers that the grades should be modified, possibly even combined with grades of domestic furnace oil to decrease tankage and simplify supply. O. F. Allen and Mr. Pender of Sinclair were among those expressing this view.

A. S. R. E.

REFRIGERATING engineers assembled at the New Yorker Hotel Dec. 6 and 7 to attend the 30th Annual Meeting of the American Society of Refrigerating Engineers. Four sessions were devoted to the presentation of twelve technical papers, only a few of which were particularly applicable to the problems of power engineers.

Unusual interest was taken in a new instrument for visual representation of heat flow demonstrated by Prof. A. D. Moore. When fully perfected this new tool, called a Hydrocal, may be of great assistance to designers in solving complex heat-transfer problems. The model demonstrated has 12 manometer tubes filled with a green fluid from a reservoir that can be raised or lowered as desired. Height of liquid in the tubes represents temperature. The manometer tubes, representing material or sections of material through which heat is to flow, can be connected in various ways by small diameter tubing whose resistance to the flow of the green fluid represents thermal resistance. The volume or diameter of the manometer tubes represents heat storage capacity. Flow through the tubes is at very low velocity so that laminar (streamline) conditions exist, and flow is directly proportional to head and thus simulates conditions of heat transfer.

By choosing connecting tubes of proper resistance, it is possible to set up thermal problems on the instrument so that the fluid level in the tubes will show temperature gradients or temperature levels may be fixed and the heat flow resulting determined. The instrument it is claimed will solve in a few minutes heat transfer problems with an accuracy of 2-3 per cent that would otherwise take days. It is of equal value to power and refrigerating and air conditioning engineers.

In, "Air as a Refrigerant," R. U. Barry presented a suggested refinement of the Le Blanc air refrigeration machine. He pointed out that the use of air had been largely abandoned because of the large sizes required and the low mechanical efficiency. By using an initial pressure of about 3,000 lb., a final pressure of 1,800 lb. and helium instead of air, many of the objectionable features of the old machines can be overcome.

While the system offered possibilities he pointed out that because of the high pressures heat transfer surfaces would be expensive to build. Discussion brought out that leakage had not been considered nor were the losses due to thermal storage capacity of the compressor material included in the computations.

The behavior of extended surface air coolers has become of increasing importance because of their use in air conditioning. The condensation of moisture from air passing through this type of cooler adds a complicating factor to prediction of performance. Under some conditions the latent heat removed by a cooler may be greater than the sensible heat and thus should be correctly accounted for.

In, "Heat Transmission in Cooling Air With Extended Surfaces," W. L. Knaus reviews the work done to establish a relation between sensible heat transmission and dehumidification, presents methods that are simple, reasonably accurate and convenient to use in allowing for moisture condensation, and gives an example.

Harry Harrison was elected president for the coming year.

PANORAMA OF PLANT POSSIBILITIES

THE POWER SHOW

STILL impressively large, though smaller than the old-time Power Show, the Eleventh National Exposition of Power and Mechanical Engineering filled two floors of New York's Grand Central Palace with practical object lessons to all who would improve their power services and lower power costs. During the whole week of Dec. 3, day and night, a total of 45,000 engineers, including many attending the annual A.S.M.E. meeting, went from booth to booth searching for specific solutions to specific problems, and also keeping always a weather eye open for the unexpected—new equipment, new hookups, new ideas. Some, at least, must have gone back home to step up their own individual performance by saving part of the fifty cents which American industry now wastes of each power dollar.

Boiler Accessories

Boilers were lacking—their makers decided not to participate; turbines and steam engines were few, as were diesel engines. As in some previous shows, the visitors missed the big units. On the other hand, there were displayed an astonishing variety of smaller units and accessories—valves, piping, refractories, boiler accessories, belts, chains, gears, variable-speed transmissions.

And instruments—in great variety, vastly improved in appearance and accuracy and general serviceability. Here, more than anywhere else, was demonstrated the actuality of industry's rapid adoption of the modern note in design, modern in appearance and modern in function—and both because the two were tied together more closely than ever before. All this is more important than engineers at first realized. They now get the point from many angles. Clean plants are better operated because men are men and not machines. For the same reason, neat-appearing plants are better operated. Designers are also human, and their better-looking instruments are, in general, better instruments, less open to the attacks of dust, moisture, fumes and dirt, fighting less inertia and friction, more accurate, easier to look at and read, built for less costly inspection and repair.

Art in Design

Some new instruments are notable for judicious application of black and chromium trim to simple clean-cut shapes. Some flowmeters have the integrator and recorder separate so that one may be taken apart without interfering with the other. The mounting of each meter on its own standard-size panel makes grouping almost as simple as assembling a sectional bookcase, and the result both workable and easy to look at.

This feeling for appearance went beyond instruments. It showed up in beautifully balanced exhibits, in skillful use of light, color and motion. Beyond question, Chicago's Century of Progress left its mark.

Reinforcing equipment shown "in the flesh" were innumerable drawings, cross-sections, photographs, including many drawings colored to show flow of steam, water and electricity. Notable example was a set of diagrams for several complete modern power plants, indoor and outdoor, including a mercury-steam installation. These included also the meters and automatic combustion control.

Models of equipment, also units cut away in part, or arranged to be opened for study, satisfied the universal desire to see how it works. Three different combustion control systems, including the master regulators for controlling a bank of boilers, were available for practical demonstration.

Eleventh National Exposition of Power and Mechanical Engineering, New York City, Dec. 3-5, displays many machines, instruments and accessories of superior design to give better power services at lower cost

Unique Equipment

Scientific stunts here and there added color to the hard-boiled presentations of practical plant equipment. There was the music transmitted as the vibrations of a beam of light from a neon crater lamp. When the beam fell on a photocell the connected loudspeaker struck up the band.

The vacuum-vapor power plant, first shown two years ago, was again in operation, making its steam almost magically from atmospheric heat and condensing it again by the cooling effect of a wet wick. It was not, as the newspapers claimed, "a first step to perpetual motion," but it was mighty interesting.

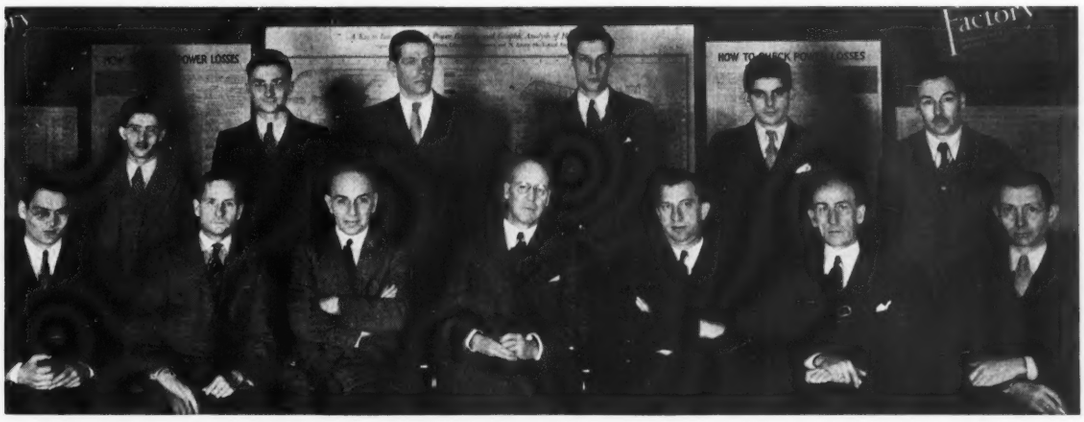
Sylphon action was dramatized by a wheel with a row of sylphon bellows on its rim, each filled with a volatile liquid. Warmed on one side by a slow steam jet, the bellows moved out, unbalanced the wheel and made it turn.

Engines

Included in engine exhibits was a vertical, multi-cylinder, uniflow, poppet-valve type with all working parts inclosed. At 900 r.p.m. it develops 100 to 150 hp., depending on steam conditions. The horizontal crankless diesel described in *Power* early this year, at the time of its first appearance at the Motorboat Show, was demonstrated again by a cutaway model. This unit is available in sizes to 500 hp. at 1,200 r.m.p. Largest prime mover exhibited was an 8-cyl. gasoline engine rated 425 hp. at 900 r.p.m. and 565 hp. at 1,200 r.p.m., suitable for direct connection to pump or generator for constant or emergency service.

In line with the growing importance of diesel engines as prime movers, one exhibit included a typical installation of a pyrometer and control switch for measuring and comparing temperatures of exhaust

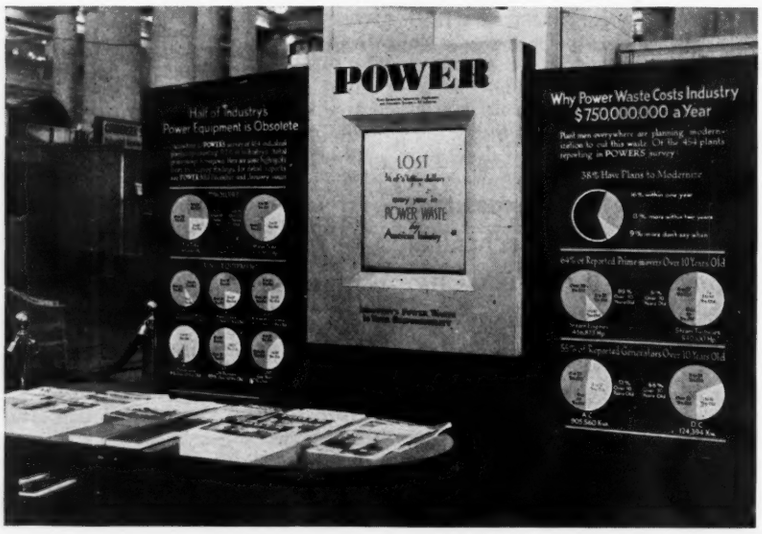
Engineering Conference Bureau, new free consulting service at the Show



gases from diesel-engine cylinders. Checking these temperatures is one of the surest methods of detecting engine troubles.

Three types of flue-gas cleaners, shown by as many companies, represented three methods of removing cinders and fly ash: mechanical, electrical, and wet-type. The electrical precipitation unit has been in use for many years. The mechanical unit, a new design, comprises a series of venturi-shaped passages through which gases pass horizontally. Speeding up of the gases as they approach the passageway throats causes the dust particles to attain a momentum which carries them to the passage walls, where they are caught in slots leading to a hopper below. The wet type leads gases through a chamber containing tubes at a slight angle. These tubes have spiral grooves on their outer surfaces down which water flows to entrap the ash and carry it away. Other indications of interest in the pure-air movement were several exhibits of smoke-density recorders and air-conditioning equipment.

Exact knowledge of plant conditions is essential if high efficiency is to be maintained. Realization of this fact resulted in a wide variety of metering equipment, probably the largest group of exhibits at the Show. Continuous records may now be had of any quantity or quality, data may be transmitted almost any distance accurately, and suitable automatic control provided.



First announcement of the Obsolescence Survey—POWER'S Booth

The tendency is definitely toward multiple-recording units. One manufacturer, for example, showed a boiler metering and control board with a 6-pointer draft gage indicating draft at preheater outlet, economizer outlet, economizer inlet, over the fire, and pressures at windbox and forced-draft fan. Another 6-pointer indicating meter showed steam flow, per cent CO_2, water flow to boiler, air flow to furnace, fuel feed, and blowdown in pounds. Two 6-point meters on this board made graphs of steam temperature, steam flow, water flow, boiler water level, temperatures at preheater inlet and outlet, of water and gas at economizer inlet and outlet, of air at preheater gas outlet, and per cent of CO_2. Strip chart speed was either 1 in. per hr. (giving 1,500 hr. records on one roll), or 3 in. per min. Another exhibitor showed recording meters producing up to 12 records on one chart, all made with one pen.

One new line of indicating and recording meters uses an oscillograph and photo-electric cell to eliminate low sensitivity and inaccuracy due to friction on indicating and recording elements. In the indicating meter, the moving element is a mirror galvanometer reflecting a light beam to a second mirror, which in turn directs it on a transparent scale, the position of the beam varying with variations in quantity measured just as a pointer does. For recording, part of the light reflected from the galvanometer mirror is allowed to pass over the stationary mirror and into a photo-electric cell which operates the recorder.

One supersensitive draft gage measures variations in pressure of the order of 0.001 in. of water. A draft controller combines gage and mercury-electric contacts in one small case. Changing draft opens or closes the contacts, thus controlling a small damper-operating motor or changing draft-fan speed. Among portable sets was a combustion test unit combining a fast gas analyzer (Orsat) and a pointer-type draft gage. A portable gas calorimeter for determining B.t.u. content, etc., gives high accuracy with convenience.

Both mechanical and electrical flowmeters were shown. One operates on a new principle, using a mercury U-tube supported on a weigh beam. When there is no pressure differential, mercury level is the same in both legs and the beam is balanced. Change in flow throws the beam out of balance, causing a motor-driven governor to load the beam and rebalance it. Motor speed is a function of flow, thus the device will integrate, record and indicate flow.

A new boiler meter for industrial service places central-station economy methods within easy reach of small industrial boiler plants and provides an easily understood method of reducing steam costs. The meter incorporates an air-flow, steam-flow mechanism and a direct reading escapement-type integrator with a 6-digit counter which reads like an automobile mileage register.

An electric flow meter is designed so that power for the operation of pointer, pen and integrator is the same throughout its entire range of measurement. The registering mechanism is moved by external power from an electric motor controlled by a sensitive relay.

A telemetering system, designed to transmit records of pressure, liquid level, temperature flow and motion over long distances, requires only two wires between sending and receiving units. Measurements may be indicated, recorded or integrated. This apparatus will operate without relays through a loop resistance of 2,000 ohms and has successfully functioned over a distance of 250 mi. Both current and voltage in the transmitting lines are small, the receiving unit magnet operating on about 0.5 watt.

The pen of one new high-speed frequency recorder will cross the 10-in. chart in less than 2 sec., and chart speed may be 4 in. per hr. to 2 in. per min. Chart range can be made almost any value from plus-or-minus 0.1 cycle up.

A new high-speed frequency controller, biased by load conditions of tie lines, enables two stations to participate in frequency control without pilot wires or other communication channels. Thus control of frequency can be assigned to the area in which frequency swings develop.

More convenient analysis of alternating current power loads is provided by a metering device which combines voltmeter, ammeter, power-factor meter and kilowatt meter in one case with suitable transformer and switching equipment. Without external transformers, the meters are good for 150, 300 and 600 volts, and 5, 25 and 125 amp. Suitable switches change voltmeter and ammeter connections from one phase to another in polyphase circuits.

Two new automatic combustion control units included an air-operated unit by which a new steam-flow air-flow meter maintains highest combustion efficiency consistent with economic considerations. The other control has an air-loaded master which transmits electrically any demands for changes in fuel and air feed.

Mechanical Transmission

Mechanical power transmissions were also extensively represented, including everything from flat belts to variable-speed transmissions and motorized gear speed reducers. One standard variable-speed transmission now has a remote hydraulic control giving high sensitivity with stability. A new transmission has a variable-speed element comprising three cone-shaped rolls supported on splined shafts and running inside a flat ring. Ring position along the rolls determines the output-shaft speed.

The tendency toward motorized gear speed reducers was more pronounced than ever this year. Several manufacturers demonstrated units for a variety of mountings and positions.

One exhibitor demonstrated advantages of modern group drives over individual drives for many power applications. Another showed a motor mounted on a pivoted base to maintain belt tension, thus avoiding belt-wearing idlers and providing short-center drives without excessive tension.

Review of

POWER and MECHANICAL EQUIPMENT

In the pages that follow **Power** presents its seventh annual review of new and improved equipment. The 418 descriptions here presented are summaries of those which have appeared in **Power** since January, 1934.

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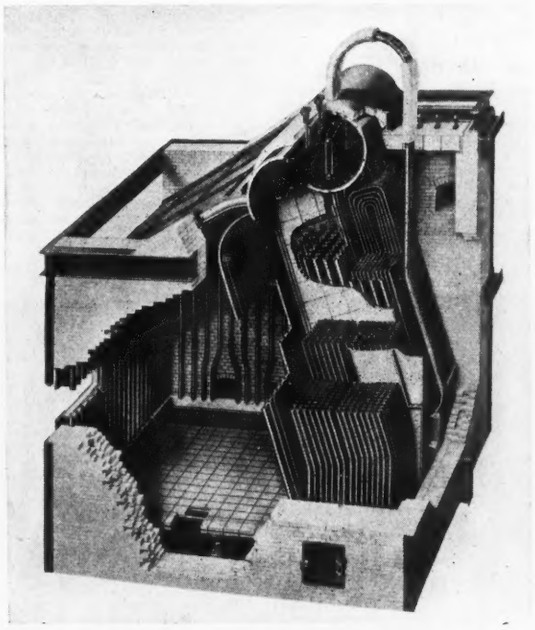
BOILERS, REFRACTORIES AND ACCESSORIES



INTEGRAL-FURNACE BOILER

COMBINES 2-drum boiler, water-cooled furnace, burners for liquid, gaseous or pulverized solid fuels, and, when needed, superheater, economizer and air heater. For industrial use where high nominal ratings with high final steam temperatures and high efficiency are required. Inclined tubes entering upper and lower drum lessen headroom. Water-cooled walls reduce furnace size for pulverized-fuel firing. Side walls stub-tubed, floor water-cooled. Rear wall refractory, cooled by bare water tubes. Slag screen protects boiler tubes and superheater, and is formed from first two rows of boiler tubes offset or staggered and spaced more widely than those behind. Low draft loss (permitting use of natural draft), high efficiency due to coordinated design.—*Babcock & Wilcox Co., 85 Liberty St., New York, N. Y.*

INSULATION BLOCK

"SUPEREX" insulation block will withstand temperature up to 1,900 deg. F. Made of special calcined diatomaceous silica and bonded with asbestos fiber.—*Johns-Manville, 22 East 40th St., New York, N. Y.*

CHROME-BASE REFRACTORY CEMENT

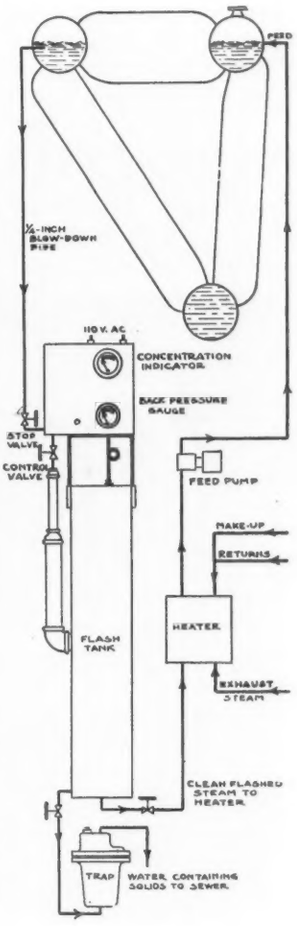
PREPARED, ready-to-use, in 250- and 500-lb. metal drums with air-tight replaceable, full-opening covers. Called "Ada-chrome." Cement is smooth and plastic, free from shortness, and workable even on refractory insulating brick. Air-sets quickly, gives non-fluxing, non-glazing finish up to 3,335 deg. F.—*Bot-field Refractories Co., Swanson & Clymer Sts., Philadelphia, Pa.*

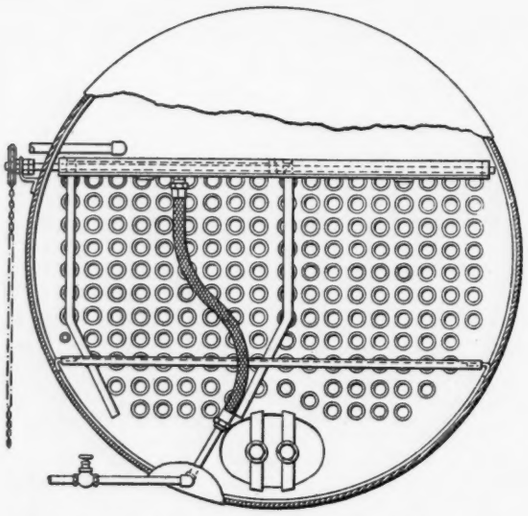
PLASTIC INSULATION

NON-METALLIC micaceous aggregate with specially tenacious binder. Coverage of 1,400 sq.ft. to the ton applied 1 in. thick. Conductivity at 200 deg. is 1.0, volume shrinkage from wet to dry 10 per cent. Average wt. applied 16 lb. per cu.ft. Suitable up to 1,700 deg. F. and reclaimable where temperature has not exceeded 1,200 deg.—*Wyolite Insulating Products Co., Div. of Wyodak Chemical Co., Cleveland, Ohio.*

CONTINUOUS BLOWDOWN SYSTEM

FRANKLIN system consists of control valve for regulating quantity of blowdown concentration indicator for reading value of concentration at any moment, special design flash tank for heat and water recovery and trap for discharging discarded water. Also removes some solid matter in suspension and oil and organic matter. Bulletin 102.—*Franklin Power Specialty Co., 1242 East 113th St., Cleveland, Ohio.*





BOILER TUBE CLEANER

B. E. T. CLEANER has double arms to reduce time and eliminate cleaning or wiping of rods. No swinging or sliding joints, no carriage, no head. Screw rod in coolest part of boiler, near front. Supporting bar and rod near front leaves clear passage for gases to stack. All nozzle arm joints welded. Flexible stainless-steel steam connection. Nozzles 4 in. out from tube ends, and travel straight across centers of tubes.—*Boiler Equipment Trust, North Amherst, Mass.*

PLASTIC INSULATING REFRACTORY

"FIRE" insulating plastic usable up to 2,500 deg. F. Stands up under flame impingement. Light, practically zero expansion. Bulletin F 1005.—*Chicago Fire Brick Co., 1467 Elston Ave., Chicago, Ill.*

SOOT BLOWERS FOR H.R.T. BOILERS

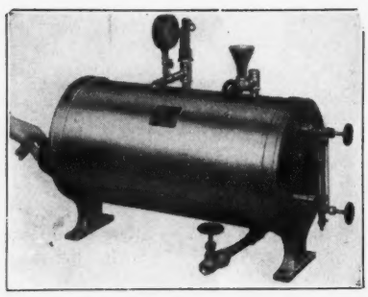
DIAMOND Strait-Line soot blower for h.r.t. boilers puts every tube directly into path of steam jet. Unit operated by opening valve in steam line and rotating chain wheel which actuates element-moving screw. No swivel joints and no flexible hose connection. Bulletin No. 354. — *Diamond Power Specialty Corp., Detroit, Mich.*

INSULATING FIRE BRICK

G-25 is highly porous brick with numerous non-communicating cells, having density of 42 lb. per cu.ft. Suitable for use under oil, gas or electric-firing, for temperatures up to 2,500 deg. F., where slagging or severe abrasion is not encountered. High reflecting characteristics. 9-in. series and packed 20 bricks to the carton.—*A. P. Green Fire Brick Co., Mexico, Mo.*

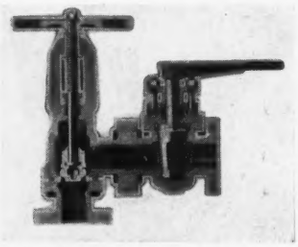
FEED- AND HOT-WATER TREATMENT

H-O-H SERIES D formulae are highly concentrated semi-solid organic products for feed- and hot-water treatments. Adjustable to meet varying water conditions and supplied in adjusted form following water analysis by company laboratories. Must be diluted before use. In 500-lb. drums only. One pound will treat 60,000 grains of calcium and magnesium hardness for scale prevention.—*D. W. Haering & Co., Inc. 3408 Monroe St., Chicago, Ill.*



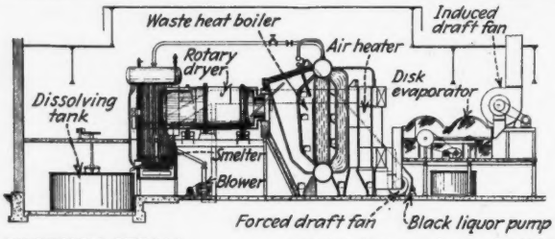
ELECTRIC STEAM GENERATORS

CAPACITY from 2 to 18 kw., and generating from 6 to 54 lb. per hr., available for 0-100, 0-200 and 0-300-lb. steam pressure range. Bulletin 5ZA.—*Commonwealth Electric & Mfg. Co., 83-105 Boston St., Boston, Mass.*



BLOW-OFF VALVE COMBINATION

FOR use where boiler blow-off occurs frequently. Holvaco-angle valve built together with quarter-turn valve. Latter is next to boiler and holds pressure so that parts may be renewed on angle valve. Seats of Monel metal, reversible.—*Homestead Valve Mfg. Co., Coraopolis, Pa.*



BY-PRODUCT STEAM RECOVERY UNIT

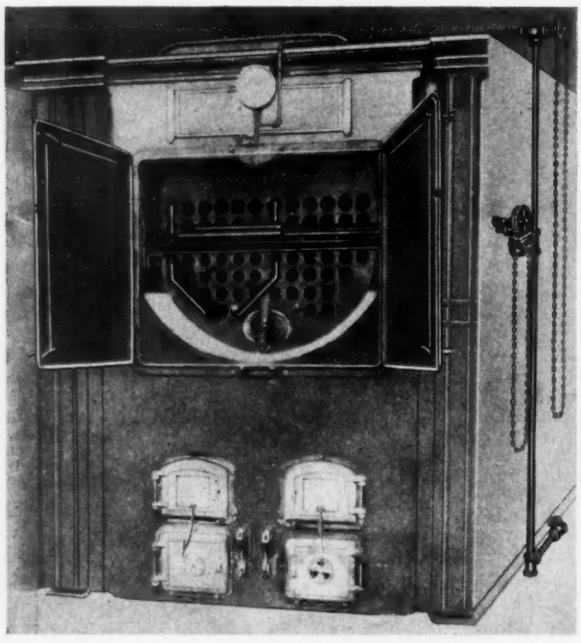
IMPROVED Murray-Waern system produces 10,000 lb. of high-pressure steam per ton of paper pulp in paper-mill heat-recovery work. Water walls in strategic places and air-sealed lip at end of rotary drier.—*Combustion Engrg. Co., Inc., 200 Madison Ave., New York, N. Y., in association with D. J. Murray Mfg. Co., Wausau, Wis.*

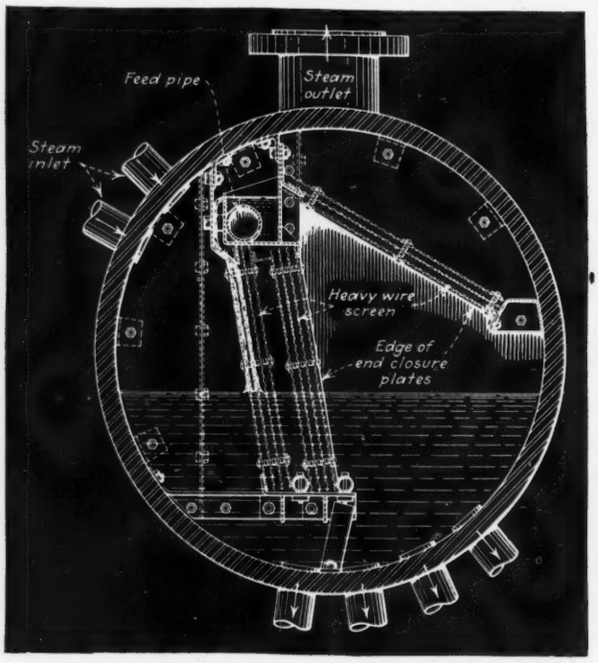
STEAM WASHER

To reduce solid content of steam leaving boiler, thus protecting superheater and turbine blading. Placed inside boiler drum. Water from feed box spreads over initial screen and forms curtain through which steam must pass on way to outlet. Heavy wire screen made up in panels which can be passed through drumhead manholes. Where all steam enters on one side of drum, a single washer

REFRACTORY FACING

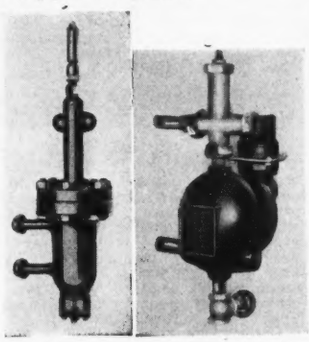
"FIRE-DRAKE" facing for refractories unites itself inseparably. When used in coal-burning furnaces along side walls of fire bed, prevents slag penetration into joints as well as lessening destructive action of slag on brick. Provides protection to refractory from infiltration of high-temperature gases. Same coefficient of expansion as fire brick, and affords protection up to at least 3,000 deg. F. Packed in 5-gal. drums in soft paste form, 1 gal. covering about 25 sq.ft. Must be fused at 1,800 to 2,000 deg. F.—*Simmons Refractories, Ever-Ready Bldg., Thompson Ave. & 30th St., Long Island City, N. Y.*





HIGH-LOW WATER ALARM

"DIAMOND" MODEL S alarm operates on pressure differential created by two inclined vertical pipes. Lower end of one pipe is at low-water level, of other at high-water level. If pressures equalize, indicating low or high water, whistle sounds.—*Diamond Power Specialty Corp., Detroit, Mich.*



LOW-WATER CUT-OFF

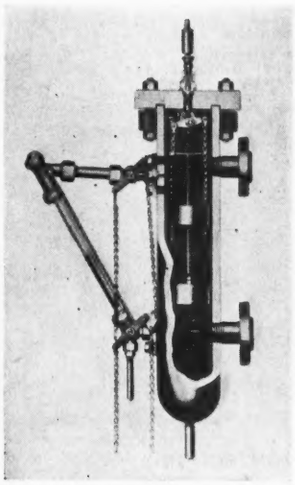
No. 60, especially for round boilers with max. steam pressure 25 lb. For 110-220 volt circuit. Cut-off inside boiler; all linkage outside. Requires no pipe cutting. Special type handles pressure to 100 lb. max. Can be combined with safety feeder for automatic boiler water-level control.—*McDonnell & Miller, 1310 Wrigley Bldg., Chicago.*

SEALING COMPOUND

"PERFECT SEAL" is universal, non-soluble, non-corrosive, and non-oxidizing sealing compound in paste form. Spreads to 0.001 in. Resists to 400 deg. F. 3- or 8-ox. tubes, 4-lb. pails, 45- and 135-lb. drums. Bulletin.—*Ideal Commutator Dresser Co., Industrial Div., Park Ave., Sycamore, Ill.*

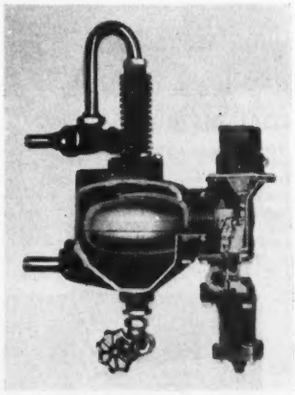
BOILER WATER LEVEL CONTROL

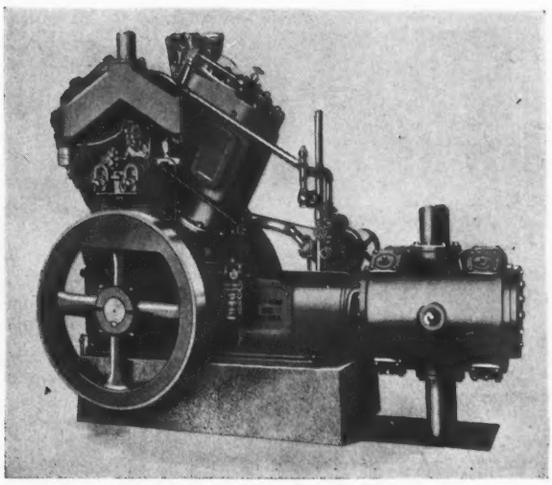
AUTOMATIC SAFETY FEEDER No. 37, for boilers to 2,500 sq.ft. Other sizes for larger units, any firing method. No. 35 low-water cut-off switch is also shown. If excessive priming or foaming causes water to leave boiler faster than feeder can supply it, switch stops burner or stoker until feeder catches up.—*McDonnell & Miller, Wrigley Bldg., Chicago. Ill.*

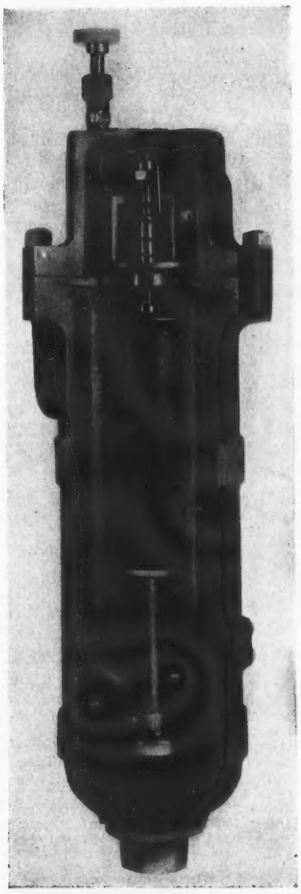


IMPROVED WATER COLUMN

FLOATLESS Hi-Lo alarm water column and Sesure-Inclined water gage now improved in design. Now smaller, lighter water column body; simpler, more flexible and more responsive operating mechanism for Hi-Lo alarm; incline connecting member at top of gage, which drains back condensate that might otherwise collect at this point and cause erosion and corrosion of glass. Working pressures to 1,500 lb. For pressures to 250 lb. water column cast iron, above that cast steel. Tubular gage glasses for pressures to 400 lb., above that flat glass inserts. *Yarnall-Waring Co., Philadelphia, Pa.*







AIR AND GAS COMPRESSORS

VERTICAL, 4-cycle, multi-cylinder, V-type gas engines with direct-connected, horizontal compressor cylinders. "XVG" units 60, 125, 190 and 260 hp. with 2, 4, 6 and 8 power cylinders respectively, two power cylinders per compressor cylinder. Bulletin.—*Ingersoll-Rand Co., 11 Broadway, New York, N. Y.*

CENTRIFUGAL COMPRESSORS

SINGLE-STAGE Type 01B centrifugal compressors and exhausters have their own shafts and bearings, thus are suitable for direct connection to standard electric motors or steam turbines, without special shaft extensions. Also adjustable to V- or flat-belt drive.—*Roots Connersville Blower Corp., Connersville, Ind.*

PORTABLE BLOWERS

"SKILSAW" blowers and cleaners now have separate unit for blowing hot and cold air and blowtorch. Bulletin.—*Skilsaw, Inc., 3310-20 Elston Ave., Chicago, Ill.*

VERTICAL COMPRESSORS

DELIVER same amount of air as horizontals of same capacity, but priced 25% lower. Inlet and discharge valves cushioned and silent. Extra large water jackets. Water-cooled intercooler.—*Gardner-Denver Co., Quincy, Ill.*

BLOWERS, FANS, COMPRESSORS

BLOWERS WITH VARIABLE-SPEED DRIVES

WHERE variations in volume are required, blowers, vacuum pumps and gas pumps connected through variable-speed drive to a constant-speed motor now supplied. Also used with heavy-duty cycloidal rotary pumps for handling viscous liquids, or for producing vacuums up to 26 in. Hg. for handling vapor and liquid together.—*Roots-Connersville Blower Corp., Connersville, Ind.*

GEARED TURBO BLOWERS

CENTRIFUGAL compressor using gearmotor for speed increase, consequently reducing size and bettering performance. Pressures 0.75 to 3.0 lb. gage, volumetric capacities corresponding to motors from 3 to 30 hp.—*Allis Chalmers Mfg. Co., Milwaukee, Wis.*

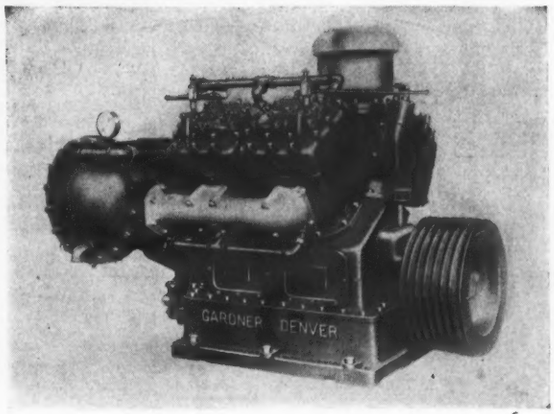
AUTOMATIC SEPARATOR

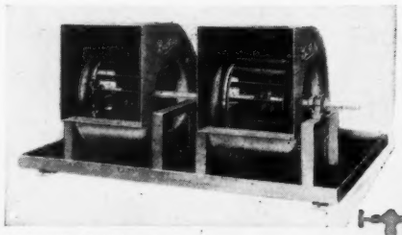
(Illustration at right)

STUARD automatic separator is based on principle that freed water, which condenses as compressed air is cooled, will be precipitated if air is suddenly expanded. Automatic vent to atmosphere through separate chamber eliminates precipitate and foreign matter collected by separator. Entirely automatic. Specially packed chamber eliminates suspended matter not easily precipitated. Sizes from ¼ to 4 in. I.P.S. Bulletin.—*Railway & Industrial Engrg. Co., Greensburg, Pa.*

ACID-PROOF FAN HOUSING

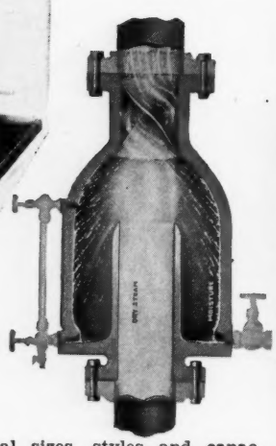
CORROSION is avoided in fan housings by a specially developed acid-proof rubber compound vulcanized to metal surfaces.—*Manhattan Rubber Mfg. Div., Passaic, N. J.*





FAN MOUNTING

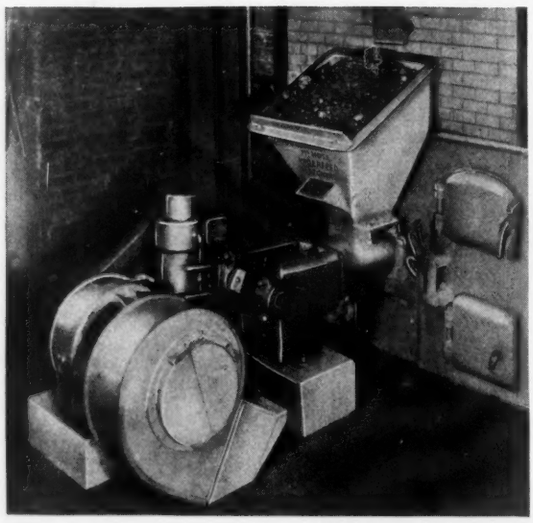
"DRIP PAN" mounting for Type HVA fans is heavy sheet metal, welded at all seams and leakproof. To combine heating and cooling coils and filters with fan. Casing sheet metal or insulating board. Unit can be mounted on rubber. Eight sizes, shipment from stock.—*Buffalo Forge Co., Buffalo, N. Y.*



SEPARATOR

CORKSCREW device near inlet gives entering steam, air or other vapor a whirling motion, throwing out liquid or solid matter by centrifugal force. All usual sizes, styles and capacities. Prevents knocking, slugging and freezing of air lines.—*Swartwout Co., 18511 Euclid Ave., Cleveland, Ohio.*

FUEL-BURNING EQUIPMENT

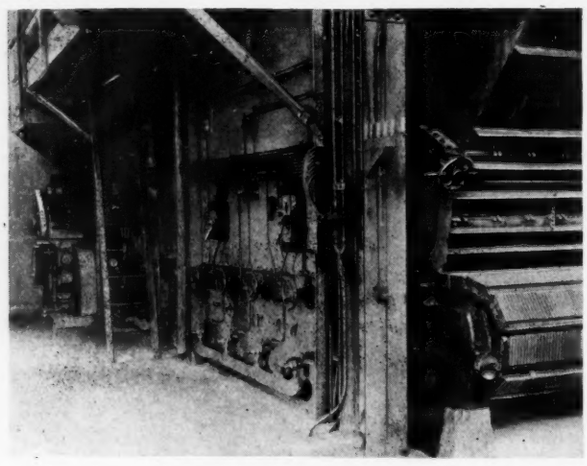


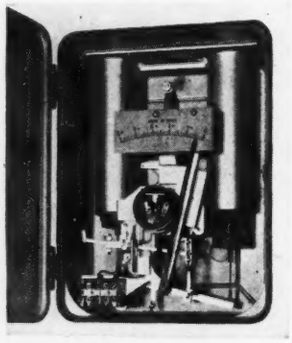
UNDERFEED STOKER

McHOSE underfeed stoker, ram type, designed for boilers of 800 sq.ft. to 3,000 sq.ft. of heating surface burning bituminous coal. Of heavy construction with few moving parts. Stoker equipment requires only about 5½ ft. of space in front of boiler, but no obstructions in front of ash door. 8-page bulletin.—*James Beggs & Co., Inc., 165 Broadway, New York, N. Y.*

TRAVELING-GRATE STOKER

COXE Design CD stoker is adaptation for wider furnaces, thus larger capacities under forced draft. Employs two or more carrier bars placed end to end instead of a single bar across stoker. Air compartments formed by plates on cross members with steam or air jets to blow siftings into longitudinal trough. Individual air compartment control. Preheated air may be used. Drive from rear shaft. Furnace widths 12 to 24 ft.—*Combustion Engrg. Co., Inc., 200 Madison Ave., New York, N. Y.*



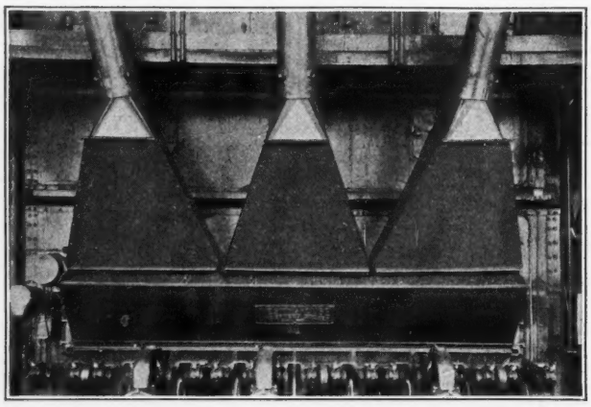


CONTROL TRIP

GUARDS against explosive mixtures of fuel and air when lighting off pulverized coal, gas or oil-fired boilers. Withholds fuel feed until boiler is thoroughly purged. Essentially two oil-sealed bells suspended from beam to measure air flow through boiler. Air flow must reach 60 per cent of capacity before contactor closes and permits operation of fuel feeder motor relay or control valve. Contactor stays closed until air flow approaches zero, thus permitting operation through entire control range without tripping out fuel feed.—*Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio.*

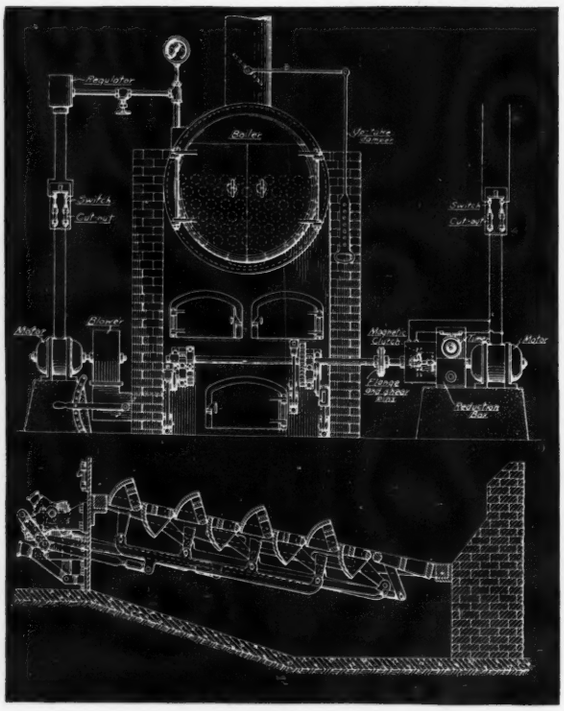
STOKER AND COMBUSTION SYSTEM

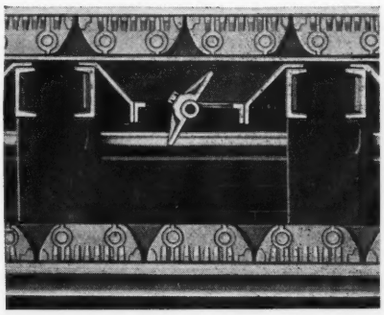
V.M. AUTOMATIC periodical stoker may be operated by hand, continuously or at desired intervals automatically. Stoker section may be automatically operated alternately or simultaneously at any required periods and in conjunction with V.M. mechanical draft. new type stoker bar heavily reinforced and with greater capacity. Units for any type or size of boiler without altering floor. Bars not only raised, but lowered, mechanically, avoiding sticking. Mechanical draft and combustion system operates automatically to supply required quantity of air in accordance with steam demand. Air also controlled by hand. Will burn any coal.—*V. M. Engrg. Co., 916 G St., N.W., Washington, D. C.*



COAL DISTRIBUTOR

NON-SEGREGATING coal distributor for stoker hopper feeding. Insures even distribution of coarse and fine portions over fuel bed. Fixed internal deflecting vanes in two series diverge and run about parallel to side of chute.—*Fairfield Engrg. Co., 322 Barnhart St., Marion, Ohio.*



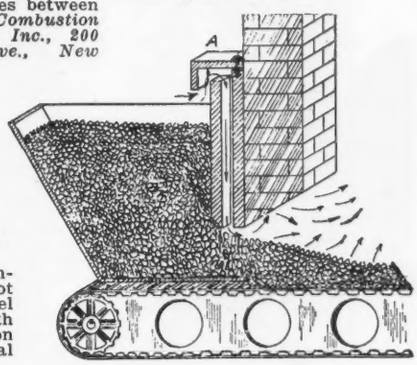


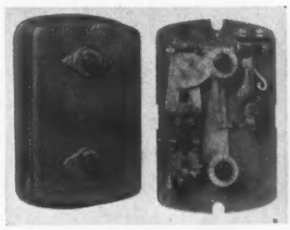
NATURAL DRAFT CHAIN-GRATE STOKER

"GREEN" stoker modified for fixed attachment of controls, greater ability to cope with expansion and simple conversion to forced draft if desired. KS design has stationary frame fixed into setting of transverse channels supported by side posts. Zone control with natural draft if desired by placing louvres between channels. — *Combustion Engrg. Co., Inc., 200 Madison Ave., New York, N. Y.*

STOKER AIR PLATE

A ALLOWS air to enter at top of fuel pot inside and into fuel along entire width of hopper. Angle iron above prevents coal from getting in. It helps ignite coal and gases at very front of furnace. Can be used on any type overfeed stoker.—*V. M. Engrg. Co., 916 G St., N.W., Washington, D. C.*

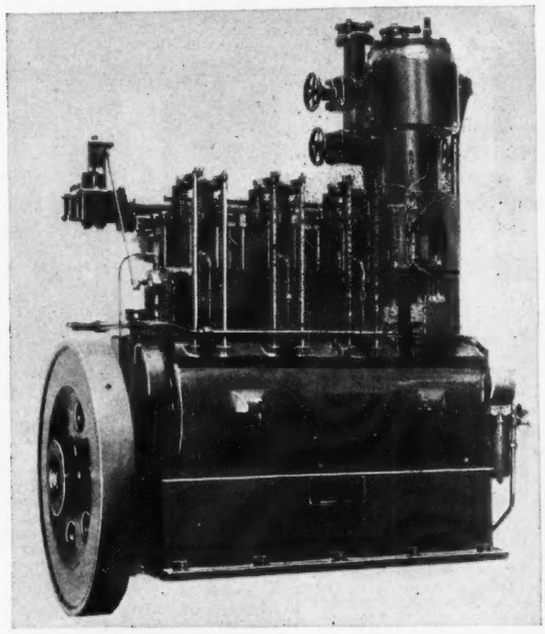




TEMPERATURE CONTROLLER

"COMFORTROL" gives complete control of heating, cooling, humidifying and dehumidifying or any two or three of these four functions. It is possible to vary ratio of temperature and humidity while leaving effective temperature condition unchanged, and also varying effective temperature as desired. Multiple human-hair humidity element, bimetallic temperature element. Range in relative humidity from 10 to 90 per cent, effective temperature from 62 to 77 deg.—*Julien P. Friez & Sons, Inc., Baltimore, Md.*

HEATING, VENTILATING, REFRIGERATING

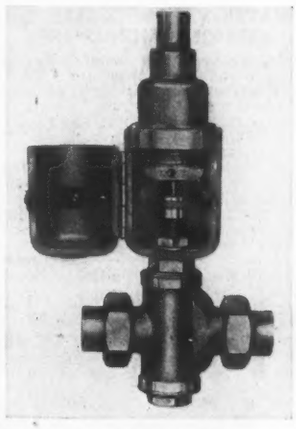


SPECIAL INSULATION

"METALLATION" is sheet aluminum cemented to both sides of heavy tough kraft paper. In rolls, 17 or 33 in. wide. Aluminum one side only in rolls 32 in. wide. Will not tarnish or corrode and reflects about 95 per cent of heat striking it. Water, wind- and odorproof. Also usable corrugated for pipe insulation. — *Reynolds Metals Co., 19 Rector St., New York, N. Y.*

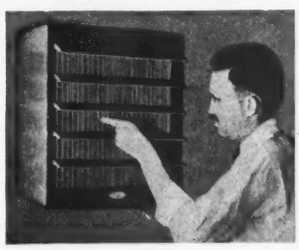
AIR-CONDITIONER

"AIRTEMP" replaces average steam raditor. 28¾ in. high, 29¾ in. long and 13⅜ in. wide. Twin centrifugal fans, connected to ¼-hp. electric motor, force air up through water coils into a chamber where air passes through two sprays of water, which washes under pressure. Air forced through unit top at rate of 600 cu.ft. per min. Unit has common heating and cooling coil.—*Temperature Corp., Chrysler Bldg., New York, N. Y.*



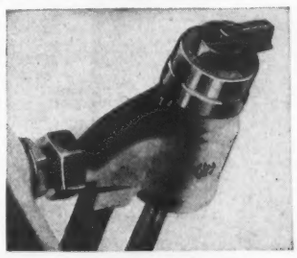
SYLPHON REGULATOR

FOR brine-cooled refrigeration systems, cold-storage room, refrigerator boxes, drinking water cooling systems, etc. Metal housing incloses valve stem and packing nut. This inclosure is filled with asbestos saturated with ammonia compressor oil permitting valve stem to work freely at temperatures as low as 70 deg. below zero. Called "Freeze Proof."—*Fulton Sylphon Co., Knoxville, Tenn.*



UNIT HEATERS

SERIES 3 has welded one-piece cabinet with integral reinforcing members, streamline tubes, patented fins, resilient motor mountings, header tanks with integral baffles to insure even steam distribution throughout element. Efficiencies of heat-transfer surface, air velocities and final outlet temperatures balanced. Capacities up to 1,200 sq.ft. E.D.R. steam.—*Fedders Mfg. Co., Buffalo, N. Y.*



INDIVIDUAL RADIATOR VALVE

MODUSTAT now has manual operating range permitting hand operation from full open to full closed. Also automatic control in range of room temperatures from 60-80 deg. Units for concealed radiation or for key setting. — *Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.*

UNIT DIESEL OR GAS-ENGINE REFRIGERATION COMPRESSORS

"UNIBLOC" unit has compressor cylinder mounted directly on base of standard vertical 4-cycle diesel or gas engine. High efficiencies result from elimination of mechanical friction, placing of suction valve in piston top, and adaptability of feather valve to higher speeds of operation. Lubrication of compressor piston and stuffing box by mechanical force-feed lubricator. Floor space requirements reduced one-half. Smaller throw on refrigeration crank permits lower piston speed. Complete range of sizes for all types of refrigerants. In larger units, number of compressor cylinders is increased to obtain required capacity.—*Worthington Pump & Machinery Corp., Harrison, N. J.*

WATER-PROOF INSULATION

WATER-PROOFED Capitol Rock Wool is available in both commercial or loose and granulated forms. Has long, tough fiber; good on cold storage work. Samples on request.—*Insulation Division, Standard Lime & Stone Co., Baltimore, Md.*

V-FRAME FOR FILTER

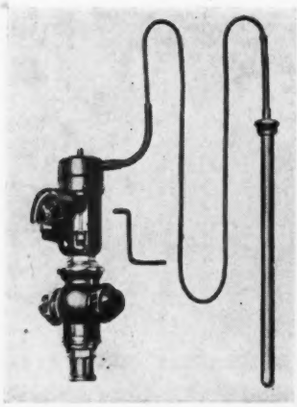
"V" FRAME arrangement for "Dustop" glass-wool air filters saves 40% of frontal area required by earlier "L" type or flat-intake face. Utilizes new form of "bayonet lock" which places pressure on outer edges of filters to force them back against flange seat at discharge face, avoiding air leaks between flexible fiberboard filter cell and frame. — *Owens-Illinois Glass Co., Toledo, Ohio.*

REFRIGERATING COMPRESSORS

Two cyl. vertical compressors for ammonia and Freon service. Capacities one to 100 tons. Frictionless bearings where applicable, tapered rollers being used for main bearings and straight roller for outboard bearings. Pressure lubrication in connecting-rod bearings in larger units. Suction valve in top of piston and discharge valve is easily removable safety head. Main stop valves, pump-out, safety valves and starting bypass incorporated in self-contained manifold. Drive either direct or through multi-V-drive. Bulletin.—*Worthington Pump & Machinery Corp., Harrison, N. J.*

CONDENSATE RETURN UNIT

"CONDENSATOR" returns water of condensation to boiler from open return line heating systems independently of boiler pressure. This is accomplished without any change in operating conditions of system, and without air-binding system or admitting steam to return side. Various capacities for installations of all sizes. Steam supply line to unit provided with stop valve and strainer. Has removable screen to permit easy cleaning. Vent trap for air also provided. Bulletin.—*Barnes & Jones, Inc., 128 Brookside Ave., Jamaica Plain, Boston, Mass.*



TEMPERATURE REGULATOR

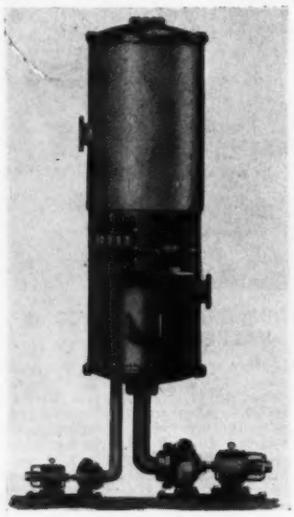
No. 943 self-contained temperature regulator. Adjusted by removable crank, one turn changing setting 10 deg. Thermal bulb in variety of sizes and materials to suit application. Operates on vapor-expansion principle with all-metal seamless Sylphon bellows for motor element. Standard temperature ranges:—30 deg. F to + 70 deg., 0-100, 50-150, 100-200, 150-250, 200-300.—*Fulton Sylphon Co., Knoxville, Tenn.*

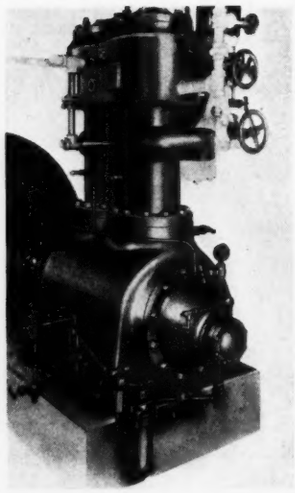
WATER-VAPOR REFRIGERATION

STEAM-JET unit operates on steam at any pressure above atmospheric. Standard ratings from 15 tons upward. Centrifugal water-vapor unit has motor or turbine direct-connected to multi-stage centrifugal compressor, both mounted directly above evaporator. This unit automatically reduces power consumption at partial loads when operating at constant speeds. Standard sizes from 50 to 300 tons refrigeration. Bulletin. — *Ingersoll-Rand Co., 11 Broadway, New York, N. Y.*

STEAM OPERATED COOLER

PRODUCES cooled water by flash or instantaneous evaporation under vacuum. Thus economical source of water at 40 to 50 deg. F. Within single tank 2 ft. in diameter and about 6 ft. high is low-pressure evaporating compartment, steam-jet compressor and condenser. Outside tank is pump for circulating cooled water and pump for removing condensing water. Auxiliary motor-driven vacuum pump on side to maintain reduced pressure in condensing compartment. Entire plant takes space 3 ft. square by 8 ft. high. Unit shown 15 ton, two others smaller.—*Elliott Co., Pittsburgh.*



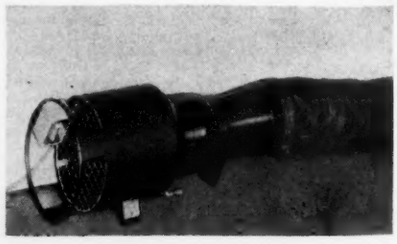


DUPLEX VERTICAL AMMONIA COMPRESSOR

2-CYL., single-acting unit with strip-plate inertia valves, automatic forced lubrication, laminated disk oil filter, safety relief valve between discharge and suction, 10x10-in. unit shown; wide range of sizes available.—*Carbondale Machine Co., Carbondale, Pa.*

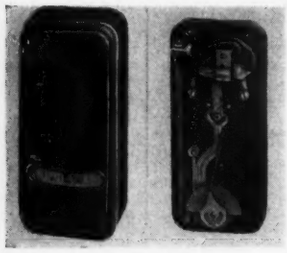
TEMPERATURE CONTROL

"WEATHERSTAT" is an outside control responding to all four weather factors — temperature, wind direction, wind velocity, and solar radiation. Following types of heating systems: steam, vapor or hot water, forced circulation. — *Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.*



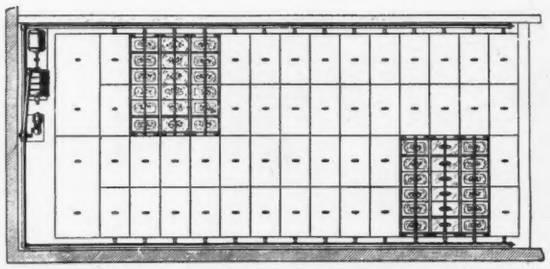
PORTABLE VENTILATOR

FOR exhausting fumes, gases and foul air from enclosed spaces. Can be placed either horizontally or vertically. When placed vertically, ventilator rests on ring attached to inlet so that fumes and gases are removed from lowest possible point. Compact unit; can be lowered through 14-in. opening. Portable and operable by one man. 8-in. diameter flexible tubing carries foul air at rate of 1,500 cu.ft. per min. Bulletin 168.—*Coppus Engrg. Corp., Worcester, Mass.*



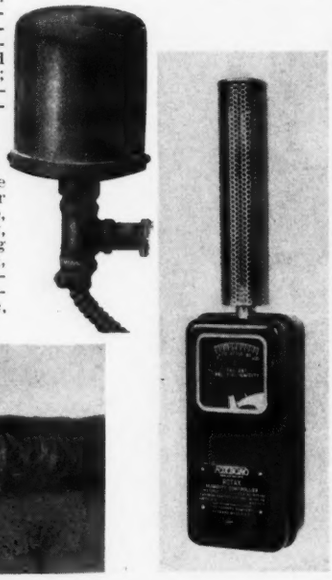
HUMIDITY CONTROLLER

THREE room-type relative humidity controllers with or without humidity indicators. Actuated by hygroscopic multiple groups of human hair, simple lever mechanism and mercury switch. Direct control of line-voltage solenoid water valves or small motors, motorized valves or as pilot control of magnetic starter. Ranges 20 to 80 per cent R.H. Will maintain total differential of 2 per cent. —*Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.*



INDICATING HUMIDITY CONTROLLER

"ROTAX" uses solenoid valves and motor valves on water, air or steam lines. Range 0-100 per cent R.H. and between 10 and 120 deg. F. Also room or duct temperature controllers in same case. Interlocking electrical circuits when required. Bulletin 184.—*Foxboro Co., Foxboro, Mass.*

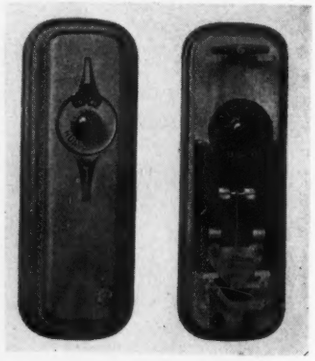


VENTILATING FANS

WALL, ceiling, floor and duct-mounted types. "Aerospot" supplies blast for 60 ft. (E-1 model) or 90 ft. (E-2 model) with widths 45 and 60 ft. Blast direction adjustable. Motor totally enclosed.—*Bendix Products Corp., South Bend, Ind.*

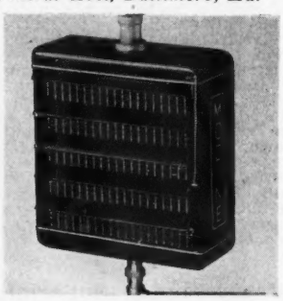
ALTERNATOR AIR-AGITATING SYSTEM

C-A SYSTEM for ice making has air circulate to one-half of cans for fixed length of time, then to those in other half, then back to first group, etc. Air in header, laterals and tubes is "trapped" in as agitating flow is shut off, thus avoiding water rise in tubes and permitting agitation to start as soon as air is switched on. Flexible rubber tube connects lateral and tube, permitting tube to be constantly vertical. Easy changing or removal.—*Carbondale Machine Co. Carbondale, Pa.*



AUTOMATIC CONTROL FOR RELATIVE HUMIDITY

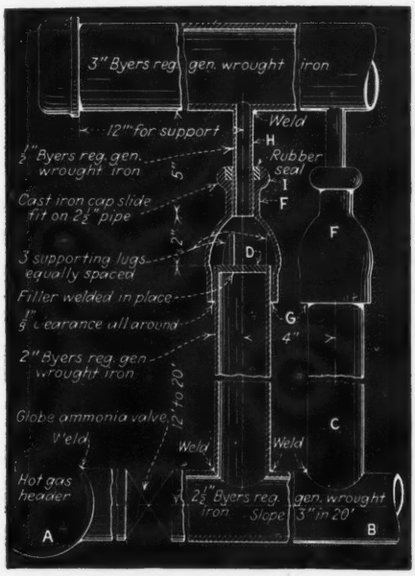
"HUMIDISTAT" Types H/4 to 7 for automatic control of relative humidity. Handles solenoid or motor-operated valves, damper motors, etc., without relays and at either low or line voltage. Element is multiple human hair, unaffected by temperatures up to 175 deg. F., accurate to within 1 per cent differential. Range 10 to 100 per cent R.H. New knob and rotating dial for setting do not require charts or psychrometers. Also, in same design, are thermostats for automatic temperature control. Range 55 to 85 deg. F., to differential of 1 deg. F. Silver contacts. Also relay-transformer sets and control assemblies. Bulletin K.—*Julien P. Friez & Sons, Inc., Baltimore St. and Central Ave., Baltimore, Md.*

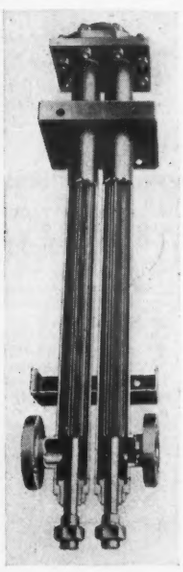


UNIT HEATERS

SIXTEEN STEAM, 14 hot-water sizes in this suspended propeller-fan type unit. Rotatable 360 deg., except for twin-unit models. Individually controlled.—*Heating Div., Modine Mfg. Co., Racine, Wis.*

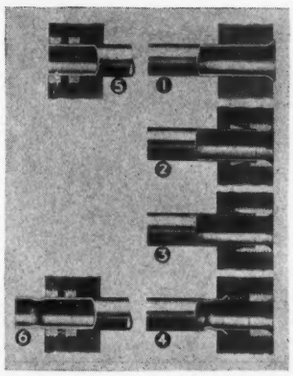
HEAT-TRANSFER EQUIPMENT

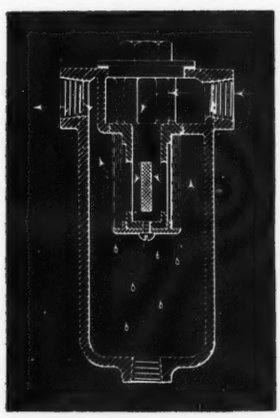




VERTICAL ATMOSPHERIC CONDENSER

COMBINED gas and liquid header *A* and *B* has vertical pipes *C* welded on with their upper ends blinded by plate *D*. Water from header *E* passes down into control nozzle *F* which has an annular space *G* that lays water on outer surface of pipe *C*. Nozzle *F* has centering lugs cast inside and is a slip fit over pipe *H* with rubber gasket at *I* for removing nozzle for cleaning. Condenser pan space required approximately ¼ that required for horizontal atmospheric condenser of same capacity. In replacement, old pan, valves and headers can be used. About 93 per cent of total weight actual condensing surface. Length of vertical pipes 40 ft., depending upon head room. Licensing by patentee.—*H. C. Guild, 1608 Clark Bldg., Pittsburgh, Pa.*





STEAM SEPARATOR

FOR application on individual steam lines serving heat-transfer and process equipment. Zig-zag moisture-laden vapor through coarse mesh screen. Screen readily removed for cleaning. Sizes ½ to 2-in.—*Johnson Corp., Three Rivers, Mich.*

TUBE-FASTENING METHOD

Two new methods of tube fastening at inlet ends of surface condenser, cooler and heater tubes fix tube firmly, allowing expansion entirely toward outlet tube sheet. Method of Fig. 2 uses gasket inserted in bottom of drilling, with soft Admiralty metal cone slipped over tube against gasket. Then hard Admiralty metal seat is slipped into cone. Against seat a streamline ferrule is screwed, so designed as to come flush with tube sheet. Alternate method, Fig. 3, consists of same gasket cone and special ferrule so beveled that it replaces seat and ferrule of method of Fig. 2.

Ferrule applies pressure against seat, compressing soft cone radially against tube diameter and giving perfect mechanical seal without measurable deformation, even in 18-gage tube. Special tools provided. Parts available in all copper and copper-nickel alloys. Folder.—*Crane Packing Co., 1800 Cuyler Ave., Chicago, Ill.*

CONDENSER TUBES

ANACONDA EXTRUDED CONDENSER tube is also rolled and drawn, then cold swaged-rolled and cold drawn. Available in standard and special alloys.—*American Brass Co., 25 Broadway, New York, N. Y.*

FUEL-OIL HEATER

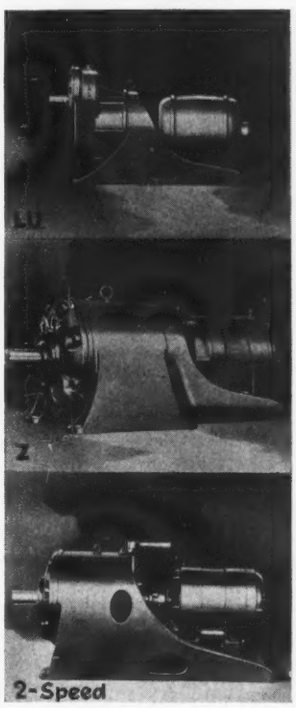
(Illustration at left.)

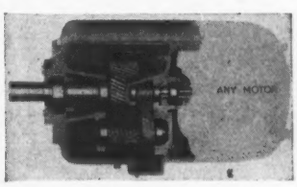
TWIN section, consisting of two parallel steel pipes, each serving as shell for G-fin pipe with return bend at one end and all inlet and outlet connections at other. Standand and interchangeable units can be arranged in series or parallel. Exterior surface of G-fin elements in eight times that of interior cylindrical surface. Steam is passed inside G-fin, oil flowed along outside. No internal joints, free expansion to avoid temperature strains, ready accessibility of entire heating surface, light weight.—*Griscom-Russell Co., 285 Madison Ave., New York, N. Y.*

FEED-WATER HEATER

INSTANT Water Heater consists of concentric steam and water chambers with copper spiral baffle in outer water chamber. Heaters may be secured in 3-, 4- and 5-in. sizes ranging in capacity from 80 to 6,000 gal. of water per hour, using steam up to 150 lb. pressure. Bulletin.—*Johnson Corp., Three Rivers, Mich.*

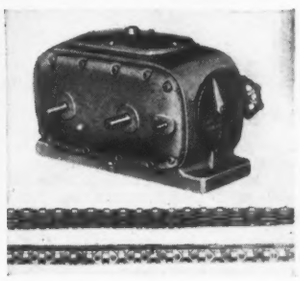
MECHANICAL TRANSMISSIONS





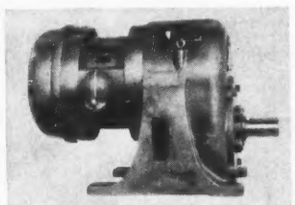
MOTORIZED SPEED REDUCER

SERIES HD "Rite-Lo-Speed" motor combines helical gear transmission and motor of any make or characteristics. Furnished with or without extended high-speed motor shaft. Vertical units footless and provided with oil pump and sprays, base ring and canopy. Principal dimensions conform to NEMA standards for motors. Bulletin. —*Falk Corp., Milwaukee, Wis.*



MOTOREDUCER

"Z" ALL MOTOR type, compact, rigid, permits use of any standard horizontal motor, including explosion-proof type. "LU" single-reduction unit. Two-speed motoreducer incorporates speed range and speed reduction in single housing. Fourth unit, not illustrated, is a vertical motoreducer. Bulletin 270 — *Falk Corp., Milwaukee, Wis.*



GEARMOTOR

TYPE S single-reduction unit has been added to line. For ratios up to 6:1. Furnished with either a.c. or d.c. motors of various types in sizes of ¾ hp. and up. Bulletin 402.—*Reliance Electric & Engrg. Co., 1042 Ivanhoe Rd., Cleveland, Ohio.*

VARIABLE-SPEED TRANSMISSION

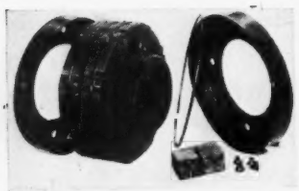
SELF-ADJUSTING, positive, variable-speed transmission for fractional horsepower duty called "V.R.S." Up to ½ hp. at maximum speed; maximum ratio of speed variation 10-1. Side-contact roller chain design shown. Speed indicator on end. Horizontal or vertical, with or without reduction gearing, with or without integral motor.—*Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill.*

BEARING BRONZE

SEMI-FINISHED outside and inside ($\frac{1}{16}$ extra metal O.D. and I.D. for finishing). Bronze stock in standard 12-, 13- and 14-in. lengths from ½-in. solid up to 8-in. outside diameter, cored up to 2½-in. diameter.—*Magnolia Metal Co., Elizabeth, N. J.*

STAINLESS STEEL CHAIN

ROLLER chains now obtainable entirely of 18-8 stainless steel. All commonly used sizes.—*Diamond Chain & Mfg. Co., Indianapolis, Ind.*

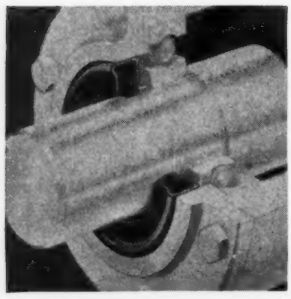


FLEXIBLE COUPLING

TYPE WH consists of two identical cast-steel flanged halves, two sheet-steel cover plates, two snap rings, and from 5 to 22 flexible elements, depending on size. Flexible elements fit into slots in peripheries of halves to cushion operation. They are of hydraulic packing; torque is transmitted by rectangular steel plate. Cushioning elements avoid lubrication and can be replaced without disturbing flanges. Safe to use at speeds up to 8,000 f.p.m.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

FLEXIBLE COUPLING

ONE-PIECE sleeve giving closer tolerance at bearing points. Floating sleeve has internal gear at each end meshing with gears on ends of shaft hubs. Runs in oil. Handbook.—*Poole Foundry & Machine Co., Baltimore, Md.*

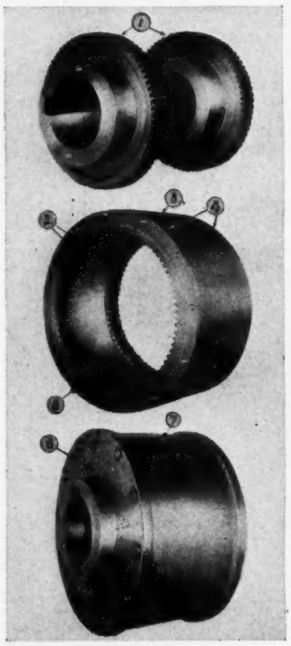


OIL SEAL

KLOZURE oil seal has four parts; adapter, spreader, sealing member and case. Sealing ring or packing is U-cross-section composition which is dense, grainless, resilient, non-porous, oil-resistant, heat-resistant, non-abrasive, tough, durable and with low coefficient of friction. Molded to exact dimension. Metal parts usually steel but can be stainless steel, aluminum, or cadmium plated if required. Pressed into bore or housing when applied. Standard sizes for shafts ⅜ to 3 in. in diameter. Cases for most shaft sizes in several outer diameters and depths. Booklet. — *Garlock Packing Co., Palmyra, N. Y.*

MOTOR-GEAR REDUCTION

ADAPTATION of Synchro-gear motor converts high motor speed to low-speed multiple torque. Unit self-contained motor with single base embodying geared transmission foundation on heavy gear pedestal base to withstand high torques. Full rated horsepower delivered to take-off shaft. Fully enclosed gear compartment. Gear ratios may be changed at place of installation. Bulletin.—*U. S. Electrical Mfg. Co., 1510 So. Western Ave., Chicago, Ill., or 206 E. Slauson Ave., Los Angeles, Calif.*

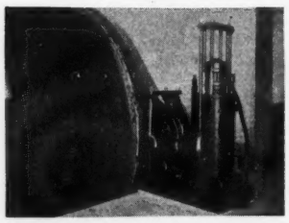


TORQUE-RING COUPLINGS

TORQUE carried by lubricated surfaces through solid-metal parts from hub to hub. Hubs (1) are alike with toothed flanges at their centers, making it possible to turn them end for end and obtain new driving surfaces. By removing either end plate (6) cover sleeve (3) and torque rings (2) can be moved in opposite direction to line up initially or to check alignment from faces of inner hubs. Fifteen sizes for shafts from 1¼ in. to 12-in. diameter with ratings from 22½ to 4,840 hp. per 100 r.p.m. Bulletin.—*Smith & Serrell, 20 Washington Place, Newark, N. J.*

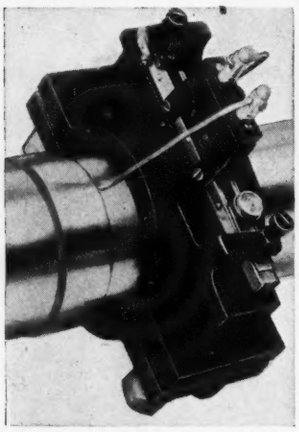
MOTOR-BELT TENSION CONTROL

"AMERICAN" base is used for flat-belt drives on short centers, maintaining correct belt tension, avoiding stretch. Belt tension is always in proportion to load. Wall, floor, ceiling or upward driving. Utilizes reaction torque, or force of motor opposite to that of its shaft. Drive at any angle throughout 360 deg. Booklet.—*American Pulley Co., 4210 Wissahickon Ave., Philadelphia, Pa.*



IMPROVED THRUSTOR

Now complete range giving 10 combinations of thrust and stroke ratings from 50 to 3,200 lb. thrust and 2 to 16 in. stroke in this self-contained combination of motor-driven centrifugal pump, oil chamber and piston. Impeller housing of centrifugal pump now stationary, rigid shaft running in ball bearings, connecting impeller and motor. —*General Electric Co., Schenectady, N. Y.*

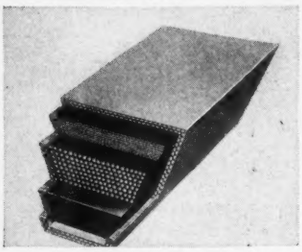


TORSION METER

MAIHAK type torsion meter measures power transmitted by a shaft, operating on principle that musical tone produced by vibrating cord depends upon rate of vibration, which in turn is proportional to square root of tension. Torsion element illustrated is fastened on shaft and revolves with it. Current led in and out by slip rings and brushes carrying leads for receiving set at any convenient distance. In receiving set is comparison cord stretched by micrometer screws. Pitch can thus be duplicated on cord in receiving set and torsion attained by comparison.—*Bacharach Industrial Instrument Co., 7000 Bennett St., Pittsburgh, Pa.*

POWER-TRANSMISSION BELTING

DESIGNED for modern small-pulley drives. Claimed to increase adhesion to compensate for small area of contact, to reduce stretch and to reduce internal friction. Vegetable-tanned leather. In single-ply belts, leather with minimum stretch is used; in double-ply, outer ply is more elastic leather. Called "Monobelt," and can be used anywhere except where belt is subject to reverse flexing. Waterproof. Bulletin A109. —*Alexander Bros., 406 N. Third St., Philadelphia, Pa.*

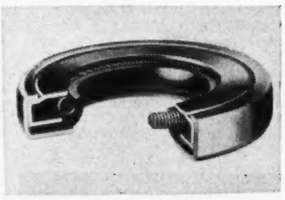


IMPROVED MULTI-V BELT

THREE layers balanced to resist stretch and cover wear. Belts compounded to reduce internal heat.—*B. F. Goodrich Rubber Co., Akron, Ohio.*

ENDLESS RUBBER BELTS

PLYLOCK belt joint outside seams imbedded or countersunk below surface to relieve it from strain and shield it from wear or windage. Protection provided by thick cushion of rubber reinforced with bias fabric vulcanized in position. To be licensed. —*B. F. Goodrich Co., Mechanical Rubber Goods Division, Akron, Ohio.*

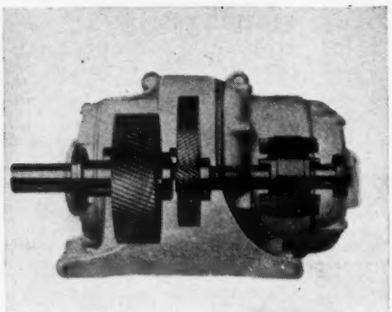


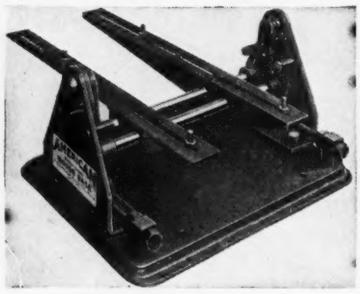
OIL AND GREASE SEAL

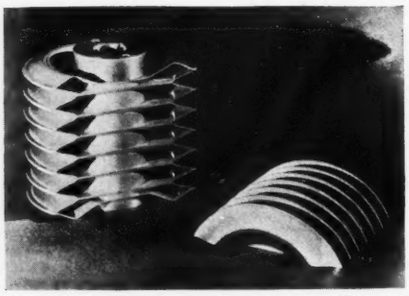
TYPE BB consists of outer steel case which locks seal assembly, garter spring pressing around sealing member, usually a processed leather, "Saetan." Outer case has press-fit accuracy of 0.002 in. on diameter. Catalog. —*National Motor Bearing Co., 1225 78th Ave., Oakland, Calif.*

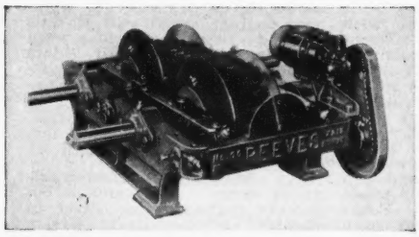
REINFORCED SHEAVE

DURO-BRACE TEXSTEEL sheave has outside walls reinforced by convex steel plate. Welded at rim and web. Interior grid-type construction. — *Allis-Chalmers Mfg. Co., Texrope Div., Milwaukee, Wis.*







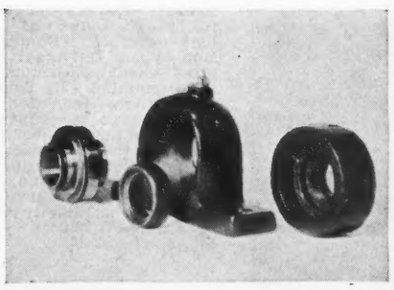


ELECTRIC VARIABLE-SPEED CONTROL

IMPROVED electric remote and electric automatic controls for Reeves variable-speed transmission. Smaller, more compact motor used on speed-shifting screw. Built-in speed reducer providing any ratio up to 1,000:1 and safety clutch to avoid overload, thus eliminating former solenoid brake. Two motors available, 100-125 or 200-250 volts, as required. Rated ⅛ hp. Automatic control, booklet T-5645; electric remote control. Booklet T-5640-A.—*Reeves Pulley Co., Columbus, Ind.*

CHAIN HOIST

IMPROVEMENTS on spur-geared chain hoist. Exposed parts zinc coated. Precision ball bearings with integral grease seals.—*Wright Mfg. Div., American Chain Co., Inc., York, Pa.*

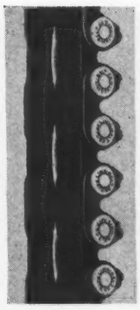


CORK-INSULATED BALL BEARING PILLOW BLOCK

WIDE inner-ring type with self-locking collar. Deep-groove large-ball design giving high load capacity, thrust as well as radial. Pre-lubrication when assembled. Lubrication renewable by means of grease tubes. Insulation is cork pad which fits into housing and around bearing itself.—*Fafnir Bearing Co., New Britain, Conn.*

HOT-MATERIAL BELT

GOLDEN PLY hot-material belt has 85 per cent greater flexing life and special cover offering greater resistance to abrasion even after exposure to heat.—*Mechanical Rubber Goods Div., B. F. Goodrich Rubber Co., Akron, Ohio.*

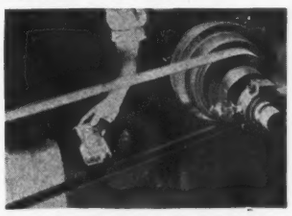


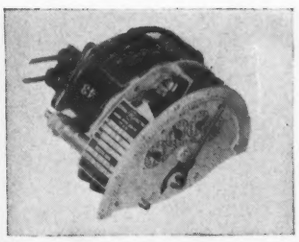
SILENT CHAIN

"SILVERSTREAK" is "dressed-up" version by bluing most of chain and silvering washers and guide bars.—*Link-Belt Co., 910 South Michigan Ave., Chicago, Ill.*

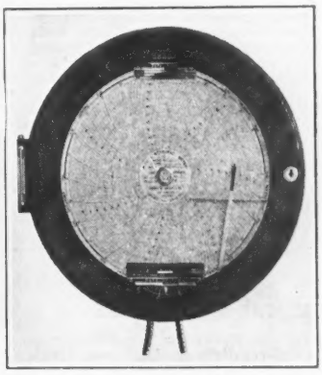
RUBBER BELT DRESSING

SOFTENS only surface. Easy to apply.—*B. F. Goodrich Co., Mechanical Div., Akron, O.*





of register in one minute. Follow-up principle used in resetting. Interval indicator shows how much time has elapsed and how much remains.—*General Electric Co., Schenectady, N. Y.*



METERS, RECORDERS AND TESTING INSTRUMENTS

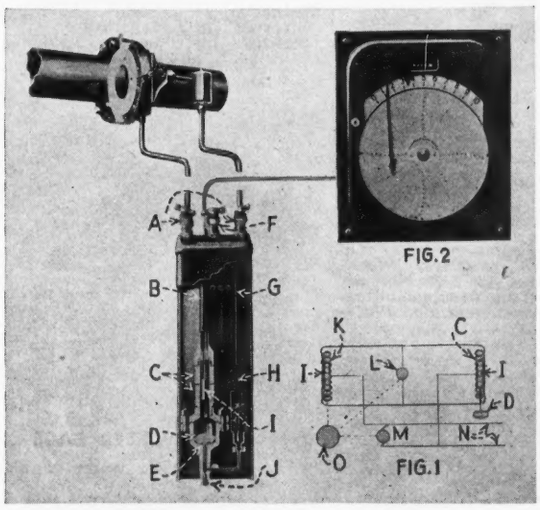


FIG. 1

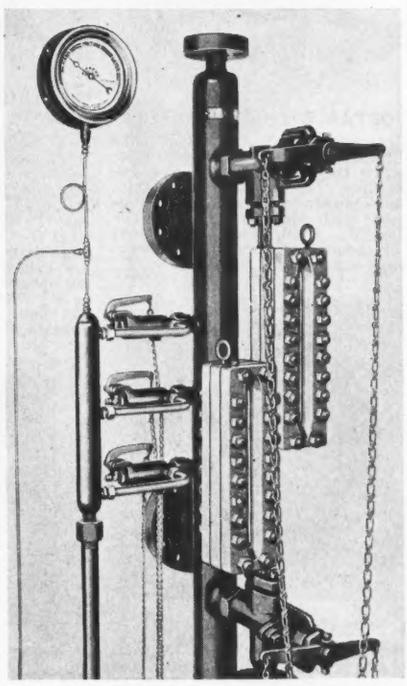
FIG. 2

PIPE FLOW METER

INDICATING, recording and integrating elements are powered from external source, thus do not lessen accuracy. Flow through pipeline causes float carrying soft-iron armature and resting on mercury in U-tube to be displaced, this being balanced electrically by shifting a similar armature in recorder, both armatures being surrounded by inductance coils of a bridge circuit carrying a.c. Unbalance deflects boom of a sensitive galvanometer which directs application of power to shift recorder armature until boom returns to neutral. Value recorded when balance is regained. Movement of 0.001 in. in transmitter armature, corresponding to 0.01 per cent change in rate of flow, will be registered. Transmitter may be several miles from receiver. In illustration: *A* meter cut-off valves, *B* high-pressure manometer tube, *C* transmitter coils, *D* float, *E* overload check valve, *F* equalizing valve, *G* low-pressure manometer tube, *H* calibrating rod, *K* receiver coils, *L* sensitive galvanometer, *M* motor, *N* applied a.c., *O* relay adjusting mechanism. — *Cochrane Corp., Philadelphia, Pa.*

DIRECT-TO-FURNACE TYPE INDICATOR

DUST-PROOF and airproof with mica glasses fitted in sheet metal mounting. Cap covering when in place. Aluminum door has standard 4x6-in. furnace blue glass. Openable to view medium fires through clear mica. Cast iron baffling fins intercept fly ash. Close-up view or periscopic heads available.—*A. E. Powell Smoke Combustion & Furnace Indicator Co., Cedar Falls, Ia.*



WATER-LEVEL DETECTOR

"DIAMOND" water-level detector shows on indicating gage whether water or steam is being discharged from gage cock. Particularly useful for high-pressure boilers. Applicable to existing installations. Bulletin 846.—*Diamond Power Specialty Corp., Detroit, Mich.*

DEMAND-METER REGISTER

CAN be applied to eight different types of G-E watt-hour meters. New testing device permits over-all "accuracy" check

ELECTRIC FLOW METER

MJL "ELECTRUFLOW" meter has 11-in. scale revolving 270 deg., white figures on black background. Or 12-in. chart with 4-in. pen arc. Ranges 0-10 to 0-80. Totalizer 5-figure type, synchronous-motor operated. Manometer for any maximum differential pressure between 20 and 200 in. of water; standard unit for pressures to 500 lb. per sq.in. 110-volt current. Bulletin 28-B1.—*Morey & Jones, Ltd., 922 S. Hemlock St., Los Angeles, Calif.*

VACUUM GAGE

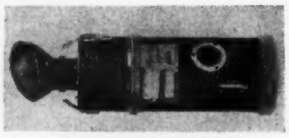
"TRU-VAC" will also indicate presence of water and other vapors. Continuous day-by-day record may be had by connecting recording device to it.—*Continental Electric Co., St. Charles, Ill.*

INDUSTRIAL BOILER METER

RECORDS steam flow from boiler, air flow for combustion and flue-gas temperature on one 12-in. chart. Also indicates steam flow on porcelain-enameled scale, and integrates total steam flow on 6-digit counter. Flush front or surface mounting, steam-flow mechanism with interchangeable head chambers (to avoid service interruption if orifice must be changed). — *Bailey-Meter Co., 1050 Ivanhoe Rd., Cleveland.*

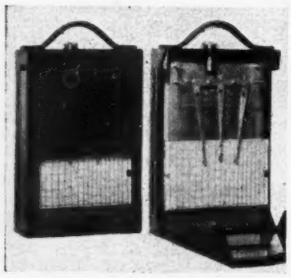
CONCENTRATION METERS FOR BOILERS

BOILER salt concentration recorder consists of two units, pressure-reducing chamber with adjustable-inlet needle valve, electrode and indicating thermometer, and recorder. Portable wall, front or flush cases.—*Esterline-Angus Co., Indianapolis, Ind.*



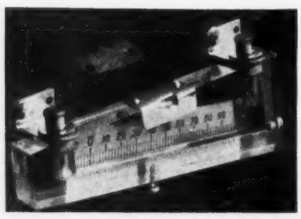
OPTICAL PYROMETERS

PYRO incorporates three separate direct-reading scales, one, 1,400 deg. F. to 2,000 deg.; second, 1,800 to 3,400 deg. (both standard calibration), and third, red-scale range from 2,200 to 3,600 deg. F. Bulletin.—*Pyrometer Instrument Co., 103 Lafayette St., New York, N. Y.*



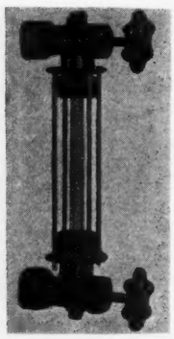
HUMIDITY AND TEMPERATURE RECORDER

CHARTS of index-card file type giving records over 30 or 10-hr. periods. Time lines common to all three pens, for ease of comparison. Week's supply of charts, ink and spare pen carried in same case. Range 0 to 100 per cent R.H., 0 to 100 deg. F. temperature, loads up to 8 amp. (inrush not above 30 amp.). Also special low ranges. One, two or three pens. Bulletin K.—*Julien P. Friez & Sons, Inc., Baltimore St. & Central Ave., Baltimore, Md.*



TRANSPARENT DRAFT GAGE

BAKELITE transparent resinoid. Tube and oil chambers accurately reamed in solid casting. Range: 0.10 to 1.0 in. draft.—*F. W. Dwyer Mfg. Co., Chicago, Ill.*

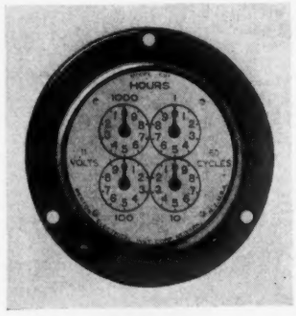


AUTOMATIC LIQUID GAGE

FIG. 1183 now has all working parts stainless steel. New rating 350 (gas-liquid pressure) at 450 deg. F. Heavy construction, automatic closure of ball checks on both valves in event of glass breakage. Booklet F-586.—*Lunkenheimer Co., Cincinnati, Ohio.*

PORTABLE THERMOMETER

LIGHTWEIGHT is furnished with either self-contained or long-distance thermometer in 8- or 10-in. case. Unit illustrated is 10-in. self-contained, Class II instrument with range of —25 to +125 deg. F. Companion instrument for recording pressures.—*Foxboro Co., Foxboro, Mass.*

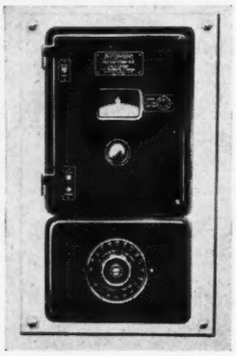


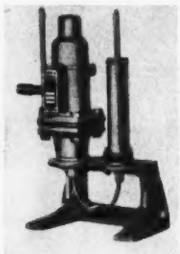
HOUR COUNTER

SPECIAL ball-bearing, self-starting synchronous motor connected through cut gears to indicating train on face of instrument. 110-volt, 60-cycle circuits, also in other voltages and frequencies. Bulletin.—*Weston Electrical Inst. Corp., Waverly Park, Newark, N. J.*

INDICATING POTENTIOMETER PYROMETER

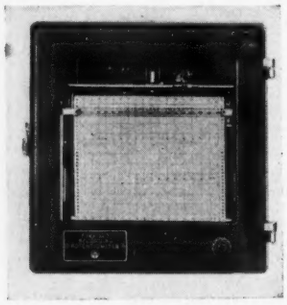
POINTER of galvanometer swings just above temperature dial and is brought to balance at same hairline index which marks measurement on temperature scale. 17-in. of scale length provided by 6-in. dial, to increase accuracy. Plain black figures. Galvanometer suitable for rough industrial use with high accuracy. Double suspension type. Universal moisture-proof case. Either surface or flush mounted. By using selecting switch, indicator can be used to give temperature readings from any number of widely scattered thermocouples. Multiple-point rotary selector switches are simple in design, and can be furnished for flush or panel mountings as illustrated. Four-page bulletin No. 192.—*Foxboro Co., Foxboro, Mass.*





ELECTRIC FLOW METER BODY

FOR measuring flow of any liquid, vapor or gas creating differential pressure across an orifice of 1.6 to 16 in. mercury. Easy to clean, rugged, simple, easy to change range. Seamless steel U-tube with union compression fittings connects high- and low-pressure chambers. Working pressures to 2,500 lb. per sq.in. Wall or floor mounting.—*Brown Instrument Co., Philadelphia, Pa.*

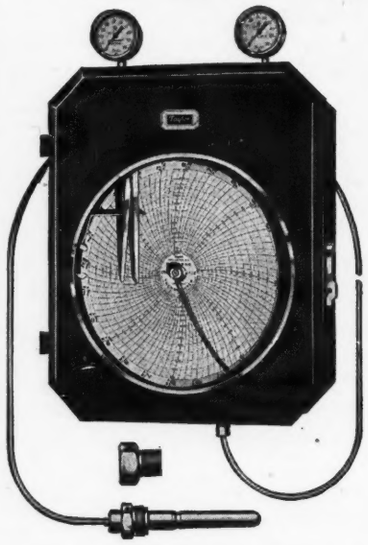


RECORDING POTENTIOMETER PYROMETER

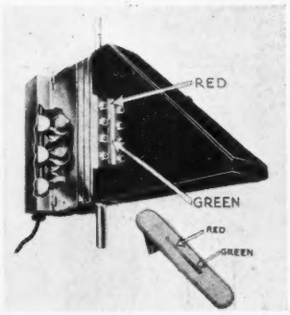
NEW type balancing mechanism produces large movement of pen or print wheel for small galvanometer deflection and moves printing mechanism quickly from one end of scale to other. Consists essentially of V-shaped cam drive and friction roller. Sensing fingers, which detect galvanometer deflection, position friction roller according to position of galvanometer pointer, V-shaped drive cam then engages and rotates roller, which in turn transmits its straight-line motion to slide-wire contact, moving it a corresponding distance. Pen or print wheel being mounted integrally with slide-wire contact, moves with it, thus making record coincide with measurement. Record dots square in shape, each record different color.—*Foxboro Co., Foxboro, Mass.*

RECORDING REGULATORS

HAVE sliding adjustment for balanced control. Regulator action quickly changed from direct to reverse. Compensating device maintains desired control under

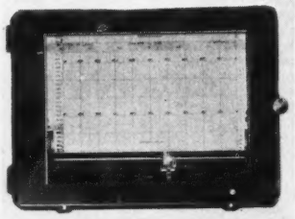


fluctuating air pressure. Easily converted to temperature or pressure instrument.—*Taylor Instrument Co's., Rochester, N. Y.*



TWO-COLOR WATER GAGE

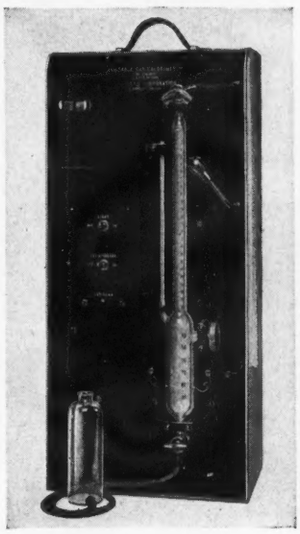
"DIAMOND" bi-color water gage and illuminator shows water green and steam red by means of light behind column. Utilizes difference in indices of refraction of water and steam. Standard single gage has 12-in. sight; double gage provides 21½-in. sight.—*Diamond Power Specialty Corp., Detroit, Mich.*



RECORDING POTENTIOMETER

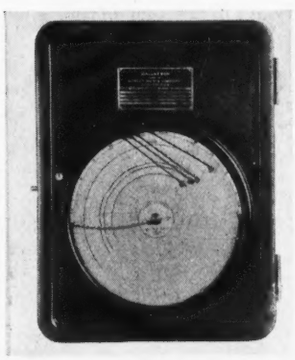
PHOTO-ELECTRICALLY balanced, light beam being reflected by galvanometer upon photocell, resulting current being amplified to close relay. Shutters intermittently operated in front of

photocell detect light-beam deflections, and synchronized electric contacts control motion of contact carriage. Universal mounting, recording from one to twelve temperatures, any standard chart range (special if required) operates on 110 or 220 volts. Standard ranges 0-500 to 0-3000 deg. F.—*C. J. Tagliabue Mfg. Co., Park & Nostrand Aves., Brooklyn, N. Y.*



GAS CALORIMETER

DETERMINES heating value of gas in B.t.u. per cu.ft. or in calories per cubic meter. Portable and requires about 5 min. for first test. Subsequent tests in 1 to 2 min. Instrument arranged for parallel tests made on gas of known heating value. Since gas samples are tested under same conditions, no corrections necessary. — *The Hays Corp., Michigan City, Ind.*

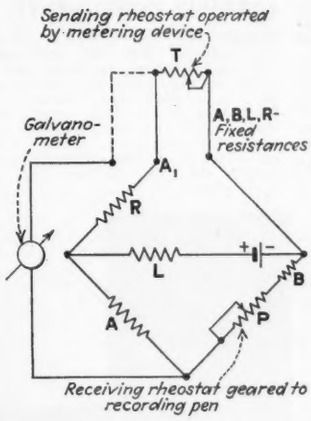


POTENTIOMETER PYROMETER

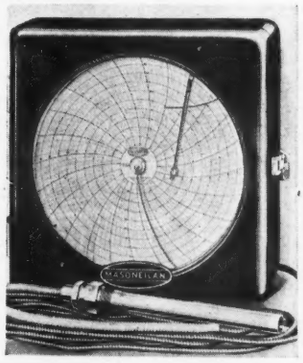
EMPLOY galvanometer-electronic relay circuit to operate slidewire resistances and recording pens. Timing contacts, chart and automatic standardizing relay contacts driven by synchronous motor. Continuous records, up to four.—*Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio.*

ELECTRONIC RELAY TELEMETERING SYSTEM

ELECTRONIC-RELAY operated Galvatron receiving element records as many as four factors on one 12-in. circular chart. Transmitting element consists principally of variable-resistance unit operated by metering device. In case of float-operated transmitter for liquid level, a float moves



a rheostat. For distances to 10 mi., accuracy to 1 per cent scale reading obtained by using 3-wire connection between metering device and remote recording apparatus, with telephone lines or equivalent as transmitting medium. Dry cells will supply current necessary for from 6 mo. to 1 yr. Additional records up to 4 can be obtained with 1 added wire per record. Illustrated is wiring diagram.—*Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio.*

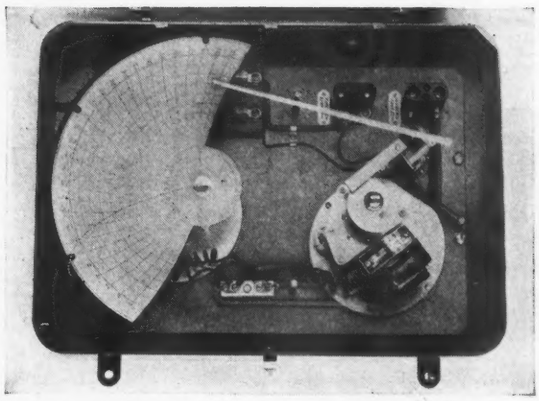


RECORDING THERMOMETER

DURALUMIN case with chromium-plated hinges and hasp. May be equipped with over-heat protector. Floating coil clamp eliminates friction and lost motion. Parts standardized and interchangeable.— *Mason-Neilan Regulator Co., 1190 Adams St., Boston, Mass.*

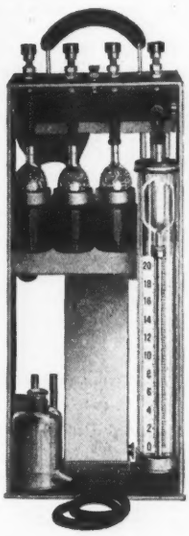
INDICATING THERMOMETER CONTROLLER

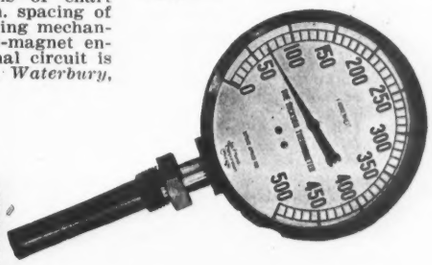
EVERY 6 sec., motor-driven control table determines position of pointer in reference to control setting and tilts mercury switch if temperature has changed. Capacities to 15 amp. at 110 volts or 10 amp. at 220 volts. Adaptable to 1-, 2-, or 3-contact control or signalling systems. Controls pressure, liquid level, etc. Catalog 6702.—*Brown Instrument Co., Philadelphia, Pa.*



ELECTRICAL OPERATION RECORDER

THIS instrument draws a spiral curve starting at outer edge of chart. Telechron cam continuously resets record-making movement to get this result. One model has chart-driving clock making 1 r.p.hr. and separate Telechron motor-driven cam making 1 revolution in 8 hr. Resulting record is spiral curve covering 8 rotations of chart and with about ¼ in. spacing of record line. Recording mechanism is small electro-magnet energized when external circuit is closed.—*Bristol Co., Waterbury, Conn.*



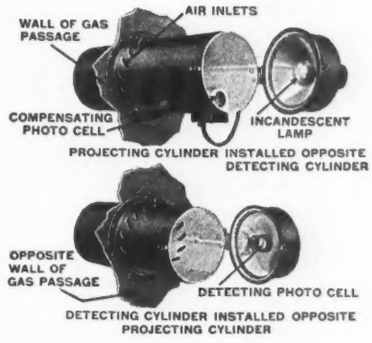


PORTABLE GAS ANALYZER

HARD rubber header and seats, new type needle valve with swivel joint, white celluloid scale 7 in. long. Two scale ranges 21% in 0.2-ml. subdivisions, or 52.5% in 0.5-ml. subdivisions. Metal parts chromium plated. Bulletin 20.—*Ellison Draft Gage Co., 214 West Kinzie St., Chicago, Ill.*

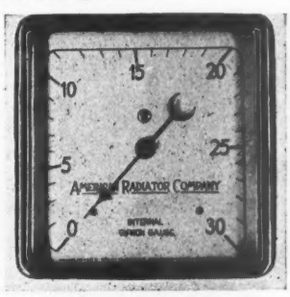
DIAL AND RECORDING THERMOMETERS

TYPES 57 and 58 Marsh-Dickson dial thermometers read temperatures at point of temperature or remotely. Distant reading unit has flexible connecting tube between. Self-contained unit has sensitive bulb fastened directly to instrument; 5-in. dial. Larger sizes on special order, in both service and flush-mounted cases. No. 59-GF gas-filled and No. 59-VT vapor tension instrument. GF is suitable for applications up to 1,000 deg. F. Gas-filled construction provides uniform scale. Vapor-tension instrument suitable for steam and hot water temperatures where operating range is not more than 30 per cent of total scale range. Increasing scale chart, graduations farther apart as temperature rises. To special order in two- or three-pen construction. GF instrument can be made with two pens, one on temperature, other on pressure, where ranges are about the same.—*Jas. P. Marsh Corp., 2073 Southport Ave., Chicago, Ill.*



SMOKE RECORDER

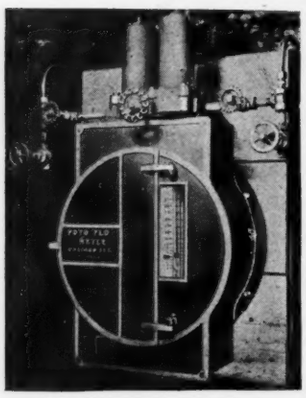
COMPENSATED for variations in light source intensity and operated by galvatron electronic relay circuit. Keeps continuous record of relative density on 12-in. chart.—*Bailey Meter Co., Cleveland, Ohio.*



SQUARE-CASE PRESSURE GAGES

VARIOUS types of pressure and combination gages now in square

cases. Bottom or back connected. Also with adjustable flanges for concealed mounting. —*United States Gauge Co., 44 Beaver St., New York, N. Y.*

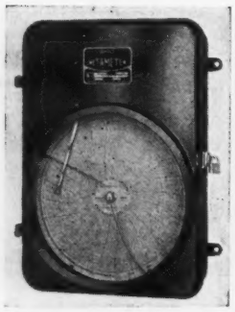


RECORDING AND INDICATING FLOW METERS

"FOTO-FLO" meter has no moving parts. Principle that of common mercury manometer actuated by differential produced by orifice in flow lines. Direct-recording. Flow is recorded by light rays on sensitized paper chart, rays being constructed by one side of mercury column. Calibrated scale on opposite side of mercury column. —*Trimount Instrument Co., 332 South La Salle St., Chicago, Ill.*

PYROMETER

"HOLD-HEET" pyrometer designed for incorporation in engines, etc. Two standard ranges, 60-800 deg. F., 60-1,600 deg. F. Manual cold-end adjustment. Direct-reading unit with total resistance only 10 ohms; maximum possible error due to external resistance less than 1 in 150 parts. Bulletin.—*Russell Electric Co., 363 West Huron St., Chicago, Ill.*



TELEMETERING SYSTEM

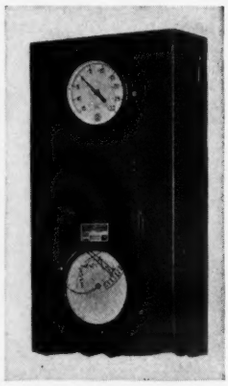
OPERATES on chromo-flow system. Consists of transmitter, recording receiver, relay and rectifier box at receiver, and 2-wire line connecting units. Will record temperature, pressure, liquid level, or motion 250 miles from source without distortion. System requires a.c. at each end. Recording receiver uses 12-in. chart as is housed in moisture-proof rectangular Model 40 M case.—*Bristol Co., Waterbury, Conn.*

REMOTE-MEASURING DEVICE

CONSISTS of transmitter and receiver electrically connected by standard telephone circuit. Water level, steam pressure and position which actuates transmitter through suitable linkage connected to pressure spring, float or Bourdon tube, may be measured by this "Telemco" system. Power usually not required at transmitter, and over short distances may be single-wire system. Can be installed with several transmitters or receivers. Automatic voltage regulator in receiver holds accuracy within 1%. Supplied for indicating pressures from 10 in. water to 1,000 lb. per sq.in.—*Pittsburgh Equitable Meter Co., 400 N. Lexington St., Pittsburgh, Pa.*

BOILER WATER METER

INDICATES and records both boiler water level and feedwater flow. Is combination of standard fluid meter (to indicate, record and integrate feedwater flow) and 12-in. indicator with dial-type for boiler water level.



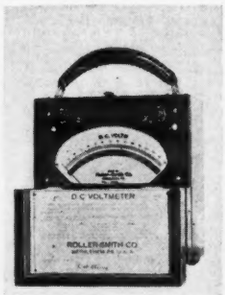
Indicator mounted directly above recording meter on small feedwater panel.—*Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio.*

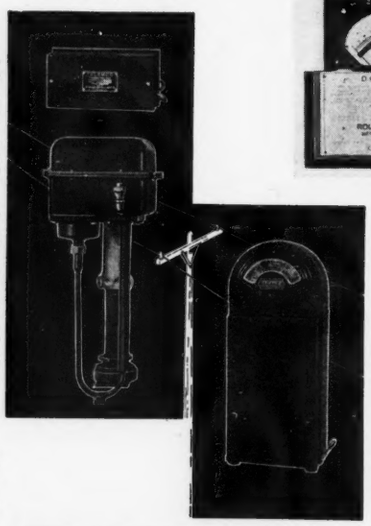
METER LIGHTNING PROTECTOR

INTENDED for use on relatively long and exposed secondary circuits up to 650 volts on polyphase watthour meters. Essentially three single-pole protectors, each made up of Thyrite disk and small series gap. Contained in steel case 5¼x4¼x2¾ in. —*General Electric Co., Schenectady, N. Y.*

PORTABLE INSTRUMENTS

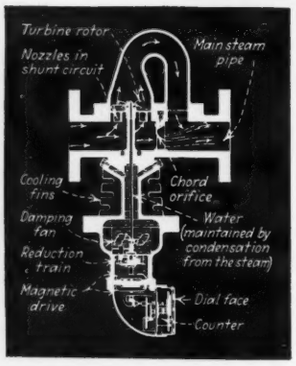
TYPES NPD (d.c.) NPA (a.c.) instruments are for standard testing. Rugged, reliable, low in cost. Accurate to one-third of 1% of full-scale value. Voltmeters to 750 volts, ammeters to 75 amp. (larger sizes with shunts). Single or double range.—*Roller-Smith Co., 233 Broadway, New York, N. Y.*





FLUID GAGES

THREE new lines of gages for measuring liquid levels and various pressures. Inno Fluidgage operates on hydrostatic principle, three liquids being available for various scale readings and heads. Inno Recuperator gages illustrated. Inno Resistogage operates on electrical-resistance principle. A number of gages may be read at a remote point on a single meter. —*Ess Instrument Co., 30 Church St., New York City.*

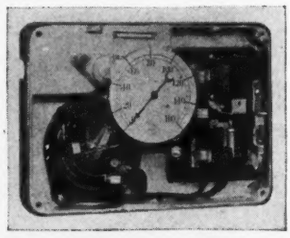


PRESSURE GOVERNORS

TYPE CR-2922 pressure governors maintain a predetermined pressure. Adjustments can be made on governors between 20 to 80 per cent of full-scale rating. Maximum differential is 60 per cent and minimum is 2 per cent of full-scale rating. Accuracy 1 per cent of full scale.—*General Electric Co., Schenectady, N. Y.*

SHUNT METER

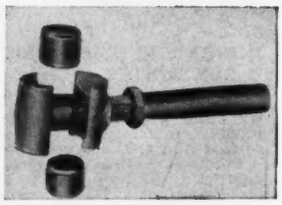
TYPE KS is orifice type for small lines. Accurate within plus or minus 2 per cent from rated capacity down to a tenth of that rate, also on temporary overloads to 50 per cent above capacity. Less accurate as air meter or when used as bypass type. No limiting maximum rate. Sizes 2 to 12 in., with four pressure ranges, 0-125, 125-275 (400 deg. F.) 175-250 (400 Deg. F.) 250-300 lb. (750 deg. F.) Capacity largest size 39-200 cu.ft. per min. Bulletin. —*Builders Iron Foundry, Providence, R. I.*



MISCELLANEOUS EQUIPMENT

HIGH-POWER BLOWER

JUMBO portable cleaner has 1-hp. GE motor, giving water column lift of 46.25 in. Fan diameter 2½ in.—*Ideal Commutator Dresser Co., Sycamore, Ill.*

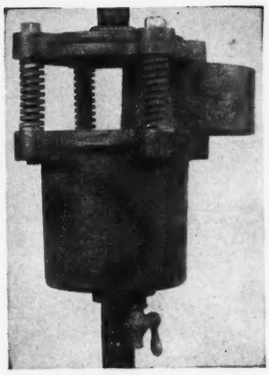


RAWHIDE-FACE HAMMER

"BASA" hammer has adjustable metal head with jaws recessed so faces are slightly mushroomed at back to hold them in. Rawhide faces replaceable. Metal faces also.—*Greene, Tweed & Co., 109 Duane St., New York.*

AUTOMATIC SPRAY CLEANER

MODEL D "Hypressure Jenny" is automatic. Operates on lighting current. Heat generated by fuel-oil burner of pressure-atomizing type. Ignition by electric spark. Designed for one-man operation. Rotary solution, water and fuel-oil pumps, direct-connected to ¼-hp. motor. Saturation selector permits any degree of vapor saturation. Pressure adjustable from 50 to 175 lb. Nozzle control permits continuous automatic operation without attendance.—*Homestead Valve Mfg. Co., Coraopolis, Pa.*



AIR FILTER

FOR use in removing oil and condensed moisture from compressed air lines. Expansion chamber, centrifugal force and baffle, and manufactured stone as filter media. — *Universal Boiler Filter Corp., 4221 Forest Park Blvd., St. Louis, Mo.*

REVERSIBLE RATCHET WRENCH

"FAVORITE" reversible ratchet wrench handles and heads have been regrouped. Old and new handles and heads interchangeable. Greater-strength handles, heads and pawls. Straight-ahead ratchet movement, with instantaneous reverse by turning pawl. Opening in head allows bolt to pass.—*Greene, Tweed & Co., 109 Duane St., New York, N. Y.*

STAR DRILLS

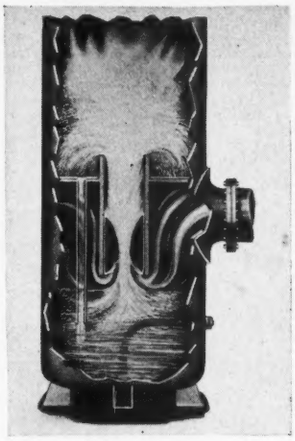
HIGH-CARBON chisel steel, drop-forged, hardened and tempered, 8-, 12-, 18 and 24-in. lengths in diameters from ¼ in. to 1 in., by sixteenths, 1-in. to 1½-in. diameter by eighths in 12-, 18- and 24-in. lengths.—*Armstrong Bros. Tool Co., 317 N. Francisco Ave., Chicago, Ill.*

CHEMICAL PROPORTIONER

FEEDS liquid chemicals into liquid lines, in boiler feedwater treatment. Operation is Tank *M* is filled with "red oil," lighter than reagent in Tank *N*. As water flows through line, a proportionate portion rises into tanks *M*, displacing red oil into Tank *N*, and forcing reagent into line.—*D. W. Haering & Co., Inc., 3408 Monroe St., Chicago,*

TANNIN BRICK

DEARBORN tannin brick is colloidal reagent combining with calcium and magnesium to form sludge instead of scale. Breaks up old scale. Destroys algae growth and controls corrosion. Briquettes are set in metal basket in system, 1 lb. brick per 1,000 gal. and 1 lb. per 1,000 gal. or makeup in closed systems, 1 lb. per 1,000 gal. in system and 0.1 to 0.5 lb. per 1,000 gal. of makeup in open systems. 2-lb. briquettes, 24 to case.—*Dearborn Chemical Co., 310 S. Michigan Ave., Chicago, Ill.*

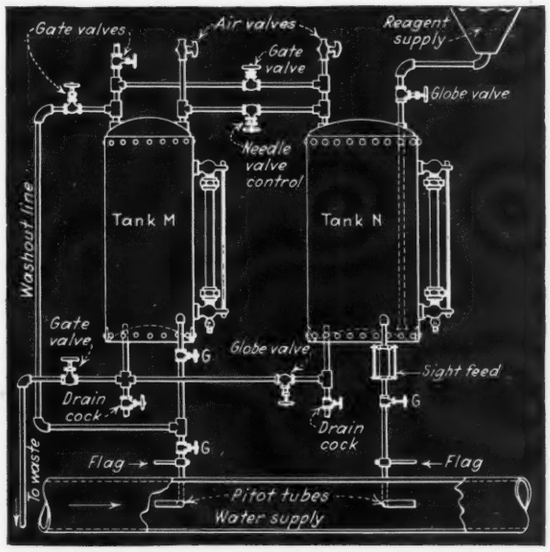


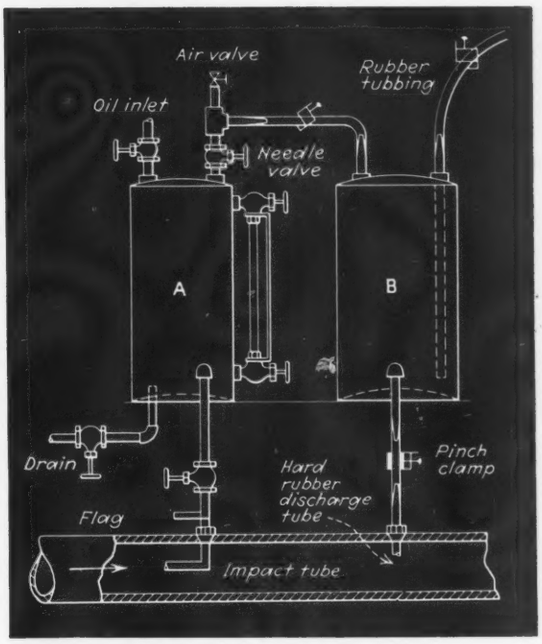
LIQUID-GAS MIXER

COMPLETE mixing of gas and liquid, or gas washing, gas cooling, oxidation, steam desuperheating, etc. can be secured with liquid-gas contactor. Any desired ratio of liquid to gas can be maintained.—*Blaw-Knox Co., Pittsburgh, Pa.*

WATERPROOFING LIQUID

STONEHARD STONTITE liquid stops leaks of concrete. Not necessary to remove hydrostatic pressure, for material is used on open side of structure.—*Stonehard Co., 401 N. Broad St., Philadelphia, Pa.*





CORROSIVE SOLUTION FEEDER

H-O-H PROPORTIONING principles now applied to feeder for hypochlorite solutions. Hard-rubber connections and rubber-lined tanks. *A* is filled with inert chemical fluid lighter than the reagent and the main fluid throughout (red oil). As main fluid flows through line, a proportionate portion rises into compartment *B*, displacing reagent into line. Machine is recharged by shutting off connections from pitot tubes and allowing reagent to flow into compartment *B*, forcing red oil to return to compartment *A*, while main fluid which has risen into *A* is drained and run into sewer. Used in purifying water. —*D. W. Haering & Co., Inc., 3408 Monroe St., Chicago, Ill.*

ALUMINUM PAINT

VACUUM process explodes powder lumps during processing, producing an easy-spreading paint of uniform brilliance. Bulletin.—*Aluminum Industries, Inc., Cincinnati, Ohio.*

RUST PREVENTIVE

STONHARD RUSTPROOFER comes in liquid form and can be either brushed or sprayed over new or rusted metal surfaces. Stops rusting immediately, and forms non-porous, moisture-proof, air-tight coating. Aluminum powder, powdered graphite or dry red lead may be mixed with this compound and applied to rusted metal surfaces for dual effect. —*Stonhard Co., 401 N. Broad St., Philadelphia, Pa.*

PROTECTIVE COATING

"PLICOTE" is very resistant to chemicals. Provides hard, tenacious film also homogeneous and flexible. Tasteless, odorless, non-toxic. Also withstands saponification in painting concrete. —*Watson-Standard Co., Pittsburgh, Pa.*

WATERPROOFING FOR WALLS

"STONHARD STONEHIDE" liquid for brushing or spraying on walls to prevent penetration of moisture. Transparent. — *Stonhard Co., 401 N. Broad St., Philadelphia, Pa.*

PROTECTION FOR METAL SURFACES

S.R.P. METAL-PROTECTIVE coatings check erosion and corrosion of metal surfaces exposed to sulphuric acid, strong alkalies, salt water, etc. Test panels and samples on request.—*L. Sonneborn Sons, Inc. 88 Lexington Ave., New York, N. Y.*

FLOOR REPAIR MATERIAL

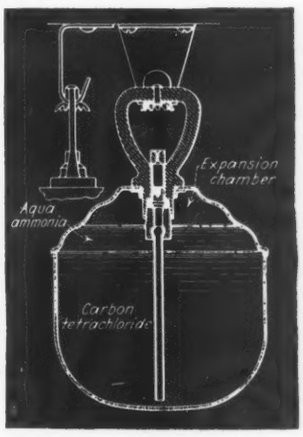
AMOLASTIC, cold mastic compound, permits concrete mix for floor resurfacing to be made hard enough to stand heavy steel wheels. Will bond to all floors.—*Floor Treatment Div., American Oil & Disinfectant Co., 129 East 26th St., New York, N. Y.*

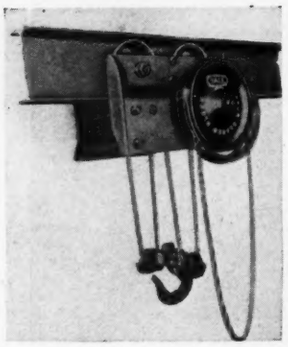
ABRASION-RESISTING CAST IRON

SUPER MANGA nickel-chromium alloy for use in units handling coke and other abrasive agents. Two to twelve times longer life than plain chilled iron. Bulletin No. 87.—*Robins Conveying Belt Co., 15 Park Row, New York, N. Y.*

AUTOMATIC SPRINKLER

"FIRETOX" units aluminum. Melting of fusible plug releases gas blanket five times heavier than air. Non-poisonous. Hermetically sealed.—*Firetox System, Inc., Attleboro, Mass.*



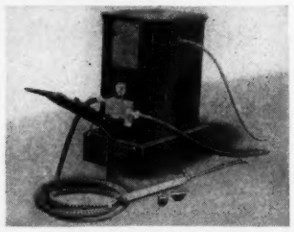


LOW-HEADROOM CHAIN HOIST

"RAIL HUGGER" chain hoist has 75 per cent less headroom than a standard hoist with trolley. Either plain or geared type. Spur-geared hoist mechanism, planetary system reduction. Screw and disk type; self-actuating load brake. Load sheaves mounted on ball bearings. Steel chains. Drop-forged steel load hooks. Trolley frame consists of outer and inner steel plate, parallel with each other, connected and supported by a steel separator block and through bolts. Wheel bearings Timken roller type. Capacities 1½ to 10 tons.—*Yale & Towne Mfg. Co., Philadelphia Div., Philadelphia, Pa.*

FLOOR RESURFACING MATERIAL

"STONHARD RESURFACER" is mixed with sand and cement, then laid cold ¼ in. thick. Material will bond to concrete, wood, brick, wood block, asphalt or composition floors, and ready for traffic 36 hr. after being laid. Will not dust and is resilient.—*Stonhard Co., 401 N. Broad St., Philadelphia, Pa.*



VAPOR SPRAY—CLEANER

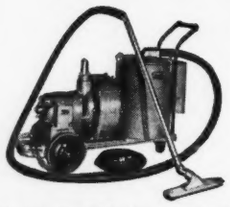
FIRELESS "Hypressure Jenny" is portable and only 20x45x52 in. Uses plant steam. Consists of water or solution tank with automatic float valve, rotary pump direct-connected to motor driven from light socket. Pressure 50 to 250 lb.—*Homestead Valve Mfg. Co., Coraopolis, Pa.*

CIRCULAR SLIDE RULE

TASCO SLIDE rule has etched black lines on ickel-silver plate. Grease and waterproof. Accuracy ¼ of 1%. Weighs 3½ oz. Disk 2¾ in. in diameter; length of multiplication-division scale 6.3 in. as against 5 in. on "A" scale of regular 10-in. slide rule.—*Tavelle Sales Co., 25 West Broadway, New York, N. Y.*

VACUUM CLEANER

INDUSTRIAL truck cleaner handled by one man. 4-stage turbine exhauster with 3-belt Texrope drive on 5-hp. motor produces 70-in. water gage suction and volume of 265 cu.ft. per min. Weight 550 lb. carried on roller-bearing, swivel-wheeled carriage. Height 57 in., width 21, length 27.—*Invincible Vacuum Cleaner Mfg. Co., Dover, Ohio.*



TUBE-END POLISHER

FOR polishing exteriors of boiler tubes before rolling in. Rotary, pneumatic, heavy-duty unit with pilots bearing on tube exterior. Entirely automatic. Ends may be polished in stacks without moving tubes.—*Chicago Pneumatic Tool Co., 6 East 44th St., New York, N. Y.*

SUCTION HOSE

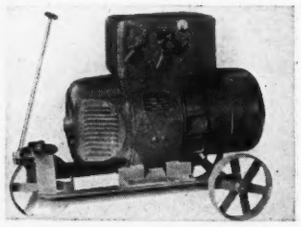
WOVEN tubular reinforcement of strong cabled cotton cords and wire. Smooth lining of specially compounded rubber. If crushed can be reshaped with mallet. Known as "Delmar"; all sizes to 4 in.—*Electric Hose & Rubber Co., Wilmington, Del.*

A.C. ARC-WELDER

PRIMARILY for heavy-current automatic welding. Three sizes with 1-hr. ratings of 500, 750 and 1,000 amp. Primaries wound for 220, 440, or 550 volts; 60, 50 or 25 cycles; single phase. Attachments for reducing secondary open-circuit voltage to about 50 per cent of normal 80, 90 or 100 volts and for obtaining currents down to 10 per cent of 1-hr. rating. Used with Type W-23 electrode.—*General Electric Co., Schenectady, N. Y.*

COMBINATION OUTFIT

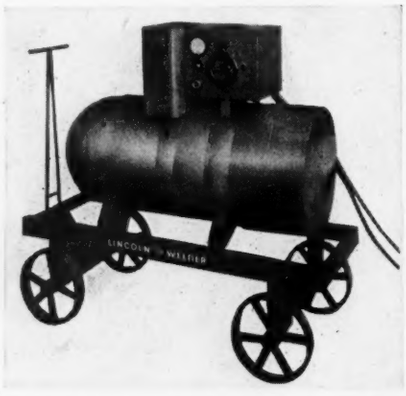
PRESTO-O-LITE 4-in. outfit has four stems and waterproof fabric carrying case. Stems for light, fine, medium and heavy soldering. Also outfit for soldering copper pipe.—*Linde Air Products Co., 30 E. 42nd St., New York, N. Y.*

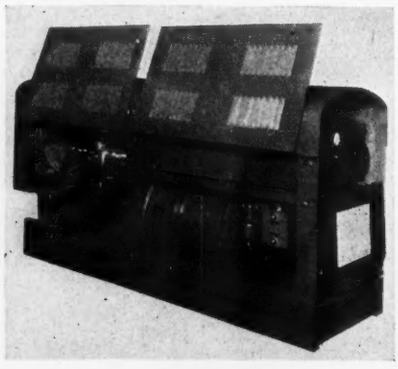


ARC-WELDING SET

PORTABLE, single-operator sets embodying self-stabilization to give better performance throughout entire welding range with any type electrode. Called WD-30 line, has no external reactor, resistor or separate exciter. Self-stabilization makes welding arc both "peppy" and stable at all times. Entire set low-hung on 3-wheeled truck so can be tipped 22 deg. from vertical safely.—*General Electric Co., Schenectady, N. Y.*

MISCELLANEOUS WELDING EQUIPMENT



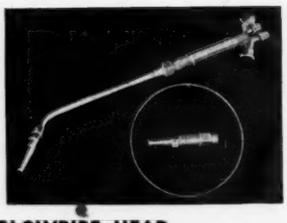


REMOTE CONTROL FOR ARC WELDERS

WITH this device known as "Lincontrol," operator taps electrode on work several times and voltage is automatically raised. Larger number of taps lowers voltage. No additional cables of other apparatus.—*Lincoln Electric Co., Coit Rd. & Kirby Ave., Cleveland, Ohio.*

BRAZING FLUX

"HANDY FLUX" for brazing either ferrous or non-ferrous metals. Has lower melting point, works efficiently over wide temperature range, greater solvent action on wider variety of oxides. ½, 1 and 5-lb. jars, in paste form.—*Handy & Harman, 82 Fulton St., New York, N. Y.*



BLOWPIPE HEAD

MULTI-FLAME Linde-Welding head is for use on W-17 or W-22 Oxweld blowpipes. Tip gives three flames, main welding flame, and two smaller auxiliary flames to preheat edges of V. Savings claimed 25 per cent on rod, one-third in welding time.—*Linde Air Products Co., 30 East 42nd St., New York.*

GAS-ENGINE DRIVEN WELDER

CLOSE-COUPLED gas-engine driven "Shield-Arc" welder is of 300 amp., 40-volt capacity. Generator mounted on engine housing with drive lined up on hardened steel and driven on cushioned rubber.—*Lincoln Electric Co., Cleveland, Ohio.*

GENERAL-PURPOSE ELECTRODE

"FLEETWELD" No. 7 is heavily coated shielded-arc electrode. High-speed, single-pass use, particularly where fit-up is poor. Tensile strength 70,000 to 80,000 lb. per sq.in. 14-in. lengths, in 50-lb. packages, all common diameters. — *Lincoln Electric Co., Coit Rd. & Kirby Ave., Cleveland, Ohio.*

COATED ARC-WELDING ELECTRODE

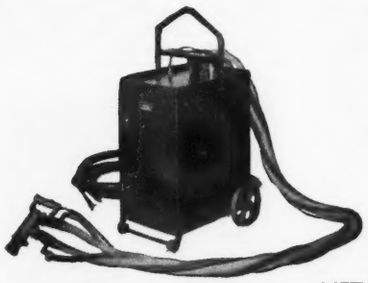
HEAVILY-COATED GE Type W-23 is used for high-speed high-quality welds in flat position. Either manual or automatic arc-welding with either a.c. or d.c. (with latter use reversed polarity). Ultimate tensile strength, stress relieved, 65,400 to 66,700 lb. per sq.in.; unrelieved, 67,400 to 71,300 lb.—*General Electric Co., Schenectady, N. Y.*

COATED WELDING ELECTRODE

ELECTRODES for arc-welding high-carbon and high-strength steels known as "Murex special A." Sound, dense, clean welds. Deposit contains some nickel and had tensile strength of 73,000 lb. per sq.in. Other electrodes give strengths to 85,000 or 100,000 lb. per sq.in. obtained by adding nickel or molybdenum or both. — *Metal & Thermit Corp., 20 Broadway, New York, N. Y.*

PORTABLE STUD WELDER

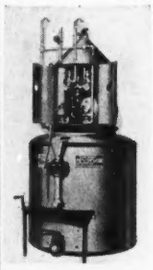
WELDING transformer and control in portable steel cabinet, primary and secondary cable



and stud-welding gun. Used for fusing stud-ends into metal surfaces for hanging piping, conduits, instruments, etc., by single-shot welding. Heavy current at low voltage goes from transformer secondary to gun through hollow, forced-air-cooled flexible cables. Transformer secondary also air-cooled. Unit complete weighs 500 lb. Handles studs from ¼ to 5/16 in. in diameter and ½ to 2½ in. long. Timer adjustable from 1/12 to 5/6 sec., varying with stud diameter. For single-phase power supplies, 25-60 cycles, 110-550 volts.—*General Electric Co., Schenectady, N. Y.*

PORTABLE ACETYLENE GENERATOR

OXWELD Type MP-4-unit has capacity of 150 lb. of quarter-size carbide. Produces 300 cu.ft. of acetylene per hour. Weight 750 lb. empty, 2,250 lb. fully charged. 87 in. high, 42⅜ in. diameter. Delivers gas at 13 lb. per sq.in. External adjustment varies range up to 2 lb.—*Linde Air Products Co., 30 E. 42nd St., New York, N. Y.*



STATIONARY ACETYLENE GENERATOR

OXWELD Type MP-5 will deliver 1,000 cu.ft. of acetylene per hr. at medium pressures. Preloaded spring (set at 13 lb. per sq.in. at factory) exerts pressure on one side of feed-control diaphragm. — *Linde Air Products Co., 30 East 42nd St., New York, N. Y.*

400-AMP. WELDER

400-AMP. d.c. welder driven by 25-hp., 230-volt d.c. motor. Unit frame, polarity reversed by thumb switch. — *Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

HIGH-TENSILE ELECTRODE

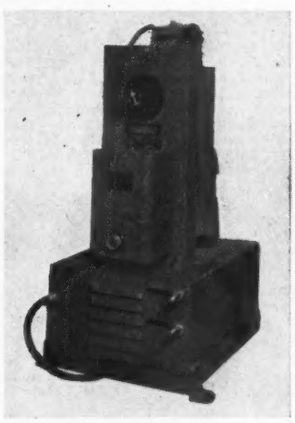
"SHIELD-ARC 85" gives welds with 85,000 to 100,000 lb. per sq.in. tensile strength. Ductility 15 to 25% in 2 in. In 5/32- and 3/16-in. sizes.—*Lincoln Electric Co., Coit Rd. & Kirby Ave., Cleveland, Ohio.*

ELECTRODE

TYPE W-22 general purpose electrode is of heavily coated or shielded-arc type, producing welds of quality required for Class I pressure vessels under A.S.M.E. Boiler Code.—*General Electric Co., Schenectady, N. Y.*

METAL-SPRAYING GUN

NEW "Metalspray" lighter, easier to operate, better balanced. Model 126 sprays all metals in ⅛ in. wire, Model 81 all metals in 12-gage B & S wire.—*Metal Spray Co., 113 Llewellyn St., Los Angeles, Calif.*

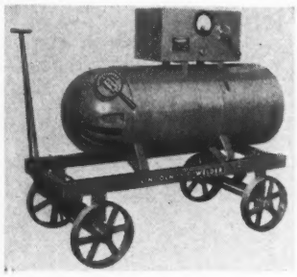


75-AMP WELDER

SMALL - MOTOR - GENERATOR unit for use on thin sheets, plates and shapes. Usable on any a.c. supply. Uses electrodes as small as 1/16 in., permitting work on metals down to 24 gage. 25-volt arc with current range 20 to 100 amp. Dual control provides independent adjustment of open-circuit voltage and welding current. Unit 20x16x40 in. high, arc-welded steel, with two small wheels on base.—*Lincoln Electric Co., Coit Rd. and Kirby Ave., Cleveland, Ohio.*

IMPROVED BLOWPIPE

NEW type ball-seat needle valve now on Oxweld blowpipes, interchangeable with older types. Hardened stainless steel ball in cage at end of valve stem.—*Linde Air Products Co., 30 E. 42nd St., New York, N. Y.*

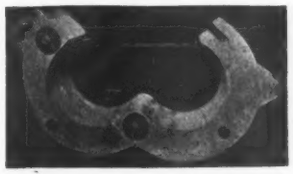


A.C. WELDER

"SHIELD-ARC A.C." takes 2- or 3-phase a.c. at standard voltages and frequencies and converts it into a.c. of lower voltage and at that higher frequency most suitable for arc-welding with either heavily coated or washed electrodes. Portable and stationary models in two sizes, smaller for continuous welding with 3/32- to 5/16-in. electrodes, larger for electrodes ⅛ to ⅜ in. Wired for 220, 440 or 550 volts, 2- or 3-phase 60 and 60 cycles.—*Lincoln Electric Co., Coit Rd. and Kirby Ave., Cleveland, Ohio.*

HARD-SURFACING ELECTRODE

DEPOSITS made with "Wear-weld" a shielded-arc electrode for building up steel surfaces to resist shock and abrasion, are air-hardening alloy steel. Good deposits in very thin layers. Two sizes—⅛ and 5/32-in. diam.—in 18-in. lengths. 50-lb. steel containers. — *Lincoln Electric Co., Coit Rd. & Kirby Ave., Cleveland, O.*



ELECTRIC WELD-STRESS RELIEVER

WILL normalize welded joints from 6 to 24 in. diameter, in pressure piping. Jointed rings of various sizes are provided and power is supplied from a special transformer mounted on a hand-truck. Speed, cleanliness and precise control. — *Detroit Electric Furnace Co., 825 Elizabeth St., West Detroit, Mich.*

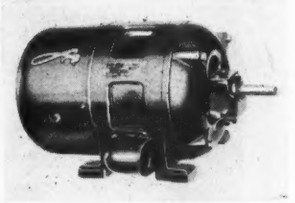
CAST-IRON WELDING ELECTRODE

"FERROWELD" for welding cast iron by shielded-arc process gives weld with greater strength and ductility than cast iron. Has steel core surrounded by heavy flux coating, which protects arc from injurious gases. Can be used at low heat, thus reducing cracking. One size only, ⅛ in. used with approximately 80-amp. current.—*Lincoln Electric Co., Cleveland, Ohio.*

MOTORS, ELECTRICAL AND ELEVATOR EQUIPMENT

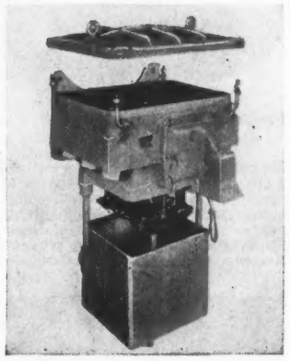
INDOOR DISCONNECTING SWITCHES

RATINGS as high as 1,200 amp. at 5,000 volts and silver-to-silver contacts. Includes hook-throw, double-operated, single- and double-blade transfer switches with half- or full-capacity blades, single-throw tandem switches with full-capacity blades, and group-operated switches controlled manually or electrically. — *General Electric Co., Switchgear Div., Philadelphia, Pa.*



CAPACITOR MOTOR

CAPACITOR-START, single-phase motors have built-in capacitor and automatic cut-out switch. Capacitor of coil-wound type without sharp turns, placed so that air circulates constantly between it and motor. Cut-out switch unaffected by voltage or starting-load variations. Sizes ¼ to 3 hp. in either horizontal or vertical types. Bulletin 514. —*Louis Allis Co., Milwaukee, Wis.*

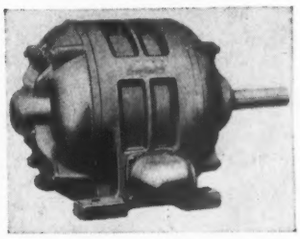


POLE-LINE OIL CIRCUIT BREAKER

TYPE P-50 moderate-capacity full automatic or non-automatic, manually or electrically operated for 200 and 400 amp., for 2-, 3-, and 4-pole single throw, and full-automatic or non-automatic manually operated 2- and 3-pole double-throw (with or without interlocks). — *Condit Electrical Mfg. Corp., Hyde Park Station, Boston, Mass.*

TESTING AMMETERS

"TONG-TEST" ammeters now available for readings to 800 amp., 400 for both a.c. and d.c. Readings without interrupting circuit.—*Columbia Electric Mfg. Co., 4319 Hamilton Ave., Cleveland, Ohio.*

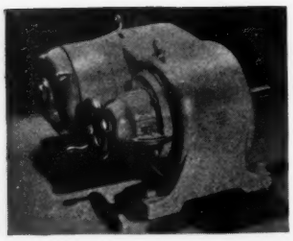


RAPID-REVERSING MOTOR

SQUIRREL-CAGE motor, capable of as many as 100 reversals per min. continuously without overheating. Light-weight rotor construction, efficient vetilation, high-torque characteristics, and shock-resisting cast-iron frame. No auxiliary ventilation needed in sizes up to 5 hp. Full line. Bulletin.—*Louis Allis Co., Milwaukee, Wis.*

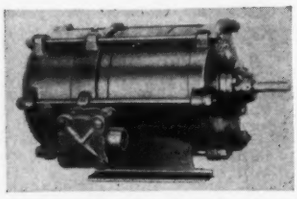
ARC ARRESTER

THIS unit, for mounting on base of contactor or line starter, includes a small capacitor and resistor connected across poles on load side of contacting device. Speeds a.c. arc extinction without introducing mechanical devices.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*



VARIABLE-SPEED MOTORS

VARIABLE motor now has Synchrogear within self-contained housing to provide operator with infinitely variable speed range. Squirrel-cage, asbestos-protected motor integral with speed changer utilizing varying effective diameter of driving disks. Bulletin.—*U. S. Electrical Mfg. Co., 1501 South Western Ave., Chicago, Ill. or 202 East Slauson Ave., Los Angeles, Calif.*

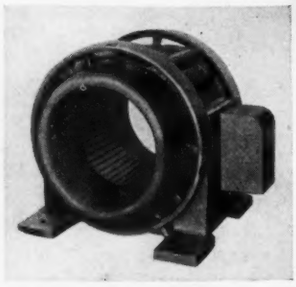


CAPACITOR MOTORS

FOR all Class I, Group D hazardous locations, these single-phase, explosion-proof, self-contained capacitor motors can be connected to either 110 or 220 volts. Non-ventilated, ½ to 1 hp.; inclosed, fan-cooled, 1½ to 3 hp.—*Louis Allis Co., Milwaukee, Wis.*

INDUCTION MOTOR

HAS protective device built into windings. Sizes from ½ to 30 hp., for either 2- or 3-phase and standard commercial cycles and voltages.—*Lincoln Electric Co., Coit Rd. and Kirby Ave., Cleveland, Ohio.*



SQUIRREL-CAGE MOTORS

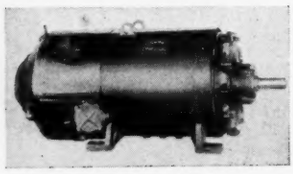
"SEAL-CLAD" motors have open-type construction. Hard, smooth, Bakelite shields over stator coils. Ratings up to 25 hp., 1,800 r.p.m. Cast-steel frames, sleeve or anti-friction bearings. —*Allis-Chalmers Mfg. Co., Milwaukee, Wis.*

ARBOR MOTOR

SIZES 2-10 hp. Especially adaptable where mounting space is limited. Self-ventilated type. Bulletin.—*Louis Allis Co., Milwaukee, Wis.*

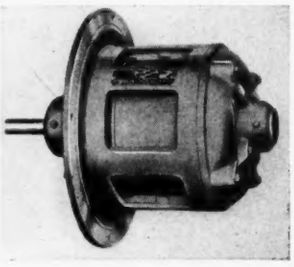
CONDENSER FOR CONDENSER-START MOTORS

WIDE variety of electrolytic and oil-filled condensers for condenser-start motors obtainable in round rubber-insulated or standard cans with or without insulating jackets, any desired terminals. Hermetically sealed.—*Aerovox Corp., 70 Washington St., Brooklyn, N. Y.*



D.C. MOTOR

FAN-COOLED, explosion-proof motors. Illustrated is a 25-hp. motor running at 806 r.p.m. Quick and easy inspection of commutator and brushes by three screw caps.—*Louis Allis Co., Milwaukee, Wis.*

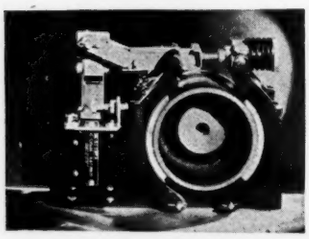


FLANGED-HEAD MOTORS

FOR use where space limitations eliminate motor seat. Flange integral part of motor head.—*Sales Service Dept., Louis Allis Co., Milwaukee, Wis.*

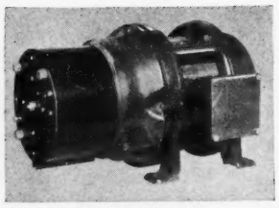
ENCLOSED FAN-COOLED MOTORS

THESE d.c. motors are available ½ to 200 hp. Dual ventilation systems used, with watertight conduit boxes and labyrinth seals at cartridge-type bearing housings.—*General Electric Co., Schenectady, N. Y.*



SMALL ELECTRIC BRAKES

THESE small a.c. and d.c. solenoid-operated brakes available in three sizes with torque ratings ranging from 3 lb. ft. to 75 lb. ft. in accordance with NEMA standards. Brake wheel is relatively large. A.C. and d.c. brakes interchangeable. Bulletin No. 511.—*Cutler-Hammer, Inc., Milwaukee, Wis.*

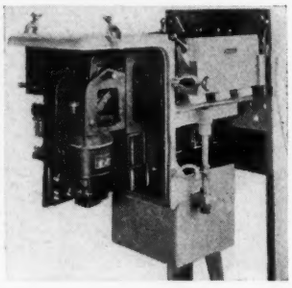


DISK-TYPE ELECTRIC BRAKE

COMPACT, smooth-acting, for mounting on many types of motors. Suitable where no more than 50 lb.-ft. of braking torque continuously or 75 intermittently. Brake also available individually. Construction Similar to multiple-disk clutch. Torque and lining wear adjustments.—*General Electric Co., Schenectady, N. Y.*

FIRE-RESISTING CABLE

PYRANOL-TREATED paper-insulated cable now for 600 volts and low-voltage network cables. Higher voltages later. Volatilizes at arc temperatures, but produces no inflammable gases and acts as fire extinguisher on paper.—*General Electric Co., Schenectady, N. Y.*

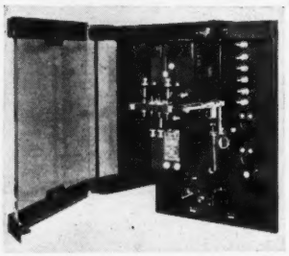


HIGH-SPEED MOTOR OPERATOR

UC-30 HIGH-SPEED motor operator consists of a universal motor directly connected through trip-free mechanism to oil circuit breaker. Closure in eight cycles. Motor suitable for operation on 110 or 220 volts, a.c., 25 or 60 cycles, and 48, 125 and 250 volts, d.c. Especially suitable for automatic throwover and automatic reclosing service.—*Condit Electrical Mfg. Corp., Boston, Mass.*

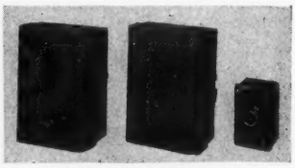
INCLOSED SYNCHRONOUS MOTOR

FOR USE where corrosive atmospheres prevail, or where motors are subject to salt water or other sprays, this motor is sealed from exterior atmosphere. Outer surfaces treated to prevent corrosion. Cooling by internal recirculation. — *Electric Machinery Mfg. Co., Minneapolis, Minn.*



GENERATOR VOLTAGE REGULATOR

PR REGULATOR accomodates two sets of contacts, one to operate motor-operated rheostat under minor voltage fluctuations, other functioning under major voltage fluctuations to actuate contactors which short-circuit theostat resistance. For either a.c. or d.c. equipment without modifying element. When used on a.c. systems of standard 3-phase type, regulator functions to maintain an average voltage on three phases. — *Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

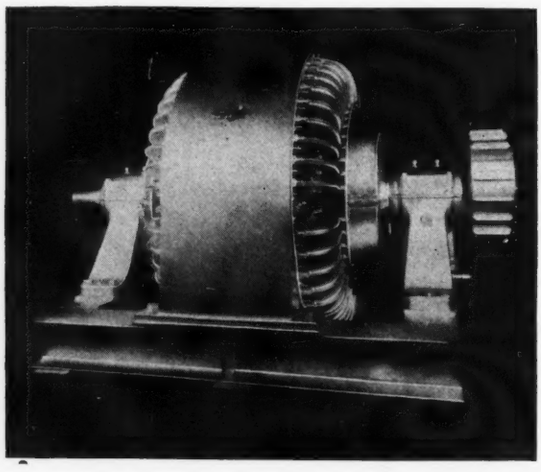


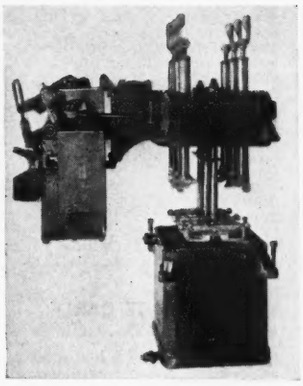
AUTOMATIC MOTOR STARTER

MEETS Underwriters' requirements and prevents accidental starting. Red stop button extends around and beyond green start button. Furnished in three types. XLA starter for 3 and 5 hp., 110, volts; also 3, 5, 7½ and 10-hp. at higher voltages. XLB starter for 7½ and 10 hp. at 110 volts; 15, 20, 25 and 30 hp. at 220 volts; 15, 20 and 25 hp. at 440 volts, and 15 and 20 hp. at 550. XLBB for 30-hp., 440 volts, and 25 and 30 hp., 550 volts. — *Lincoln Electric Co., Coit Road & Kirby Ave., Cleveland, Ohio.*

ELECTRIC TAPE

GOODRICH mending and electric tape is 90 per cent pure rubber; single thickness has tested to 8,000 volts. Tested and listed by Underwriters' Laboratories. —*B. F. Goodrich Co., Akron, Ohio.*



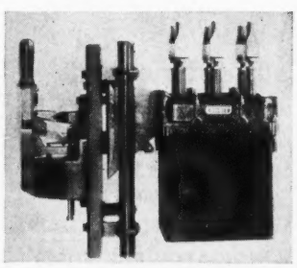


OIL CIRCUIT BREAKER

TYPE ED-20 built in sizes for 600 amp. at 15,000 volts, 1,200 amp. at 7,500 volts, and 2,000 amp. at 5,000 volts with interrupting capacity of 50,000 kva. All poles in one tank, high-speed inclosed mechanism. Standard or reverse frame mounting. — *Condit Electrical Mfg. Corp., Boston, Mass.*

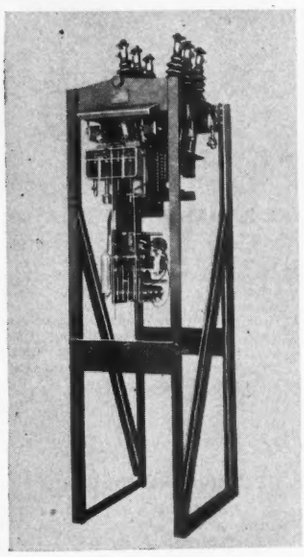
OIL CIRCUIT RECLOSER

TYPE FP-19 for circuits from 2,200 volts to 7,500 volts and 50 amp. continuous loads. Only two connections to distribution circuit, no control power necessary. Device opens promptly on short circuit, then closes automatically after several seconds. Will go through this cycle three times. If short is not cleared then device will lock itself open. —*General Electric Co., Schenectady, N. Y.*



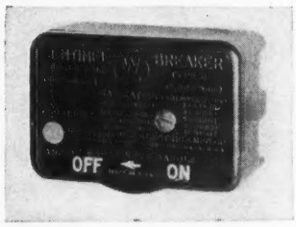
OIL CIRCUIT BREAKER

TYPE E-47 medium-capacity switchboard type oil circuit breaker for 600 amp. at 7,500 volts or 800 amp. at 2,500 volts in 2-, 3- and 4-pole units. Interrupting capacity rating 25,000 kva. Manually, solenoid or universal motor operated. High-speed breaker of enclosed-mechanism type.—*Condit Electrical Mfg. Co., Hyde Park Station, Boston, Mass.*



OIL-BLAST BREAKERS

TYPE FKO-127 line of outdoor, oil-blast, trip-free circuit breakers for station and distribution service. Rectangular-tank type, operated manually or electrically. Either pole or framework mounting. Automatic reclosing equipment can be furnished as self-contained unit, shipped assembled. Breakers rated 400 and 600 amp., at 7,500 volts, and have interrupting rating of 50,000 kva. Ratings in accordance with N.E.M.A. standards recently adopted.—*General Electric Co., Schenectady, N. Y.*



BREAKER

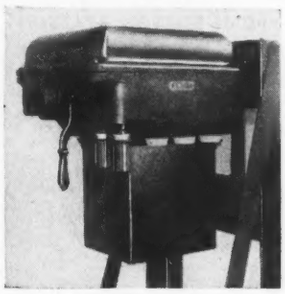
TYPE H "Sentinel," single- or double-pole. Combination bimetal and auxiliary heater and proper proportioning of parts gives self-protection. Nineteen thermal element ratings from 1.4 to 14.2 amp. for motors of 1.1 to 12.9 amp.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

OIL CIRCUIT BREAKER

TYPE FK44B-Y1 oil-blast circuit breaker is recommended for starting and jogging service or for severe-duty applications. Ratings are 15,000 volts at either 600 to 1,200 amp., 1-sec. short-time inrush rating of 60,000 amp., 5-sec., short-time rush rating of 50,000 amp., and an interrupting rating of 100,000 kva. — *General Electric Co., Schenectady, N. Y.*

OIL CIRCUIT BREAKERS

FHKO-339 LINE of outdoor oil-blast circuit breakers now includes voltage ratings over 34.5 kv. Operating mechanism frame now welded to breaker dome 46-kv. breakers have L-type heavy-oil-filled bushings. Higher voltage breakers have F-type bushings. On 69-kv. unit, new weighs 690 lb. less than old, with 30 ft. less welding and 17 ft. less gasketing.—*General Electric Co., Schenectady, N. Y.*



INDUSTRIAL TYPE OIL CIRCUIT BREAKER

E-10 MANUALLY indoor oil circuit breaker can be supplied full automatic or non-automatic, 3-pole, single-throw for 300 amp., or less, at 2,500 volts, with interrupting capacity of rating of 10,000 kva. Feature is improved copper contact structure. With this type of contact it is suitable for either general purpose or motor starting. Also has provision for three series or current transformer trip coils and an undervoltage attachment, all with or without delayed action.—*Condit Electrical Mfg. Corp., Hyde Park Station, Boston, Mass.*

OPEN FUSE CUTOUTS

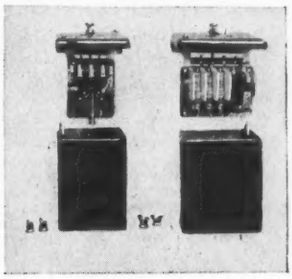
WITH drop-out fuse-holders, so that suitable ratings may be chosen for all distribution circuits up to 15,000 volts. Three units, all fusible from 1 to 100 amp., are rated at 5,000, 7,500/12,500Y and 15,000 volts, with interrupting capacity of 1,200 amp.(R.M.S.) Two other units, previously announced, can be fused from 1 to 60 amp. at 7,500/12,500Y and 15,000 volts, with an interrupting capacity of 1,200 amp.(R.M.S.) — *General Electric Co., Schenectady, N. Y.*

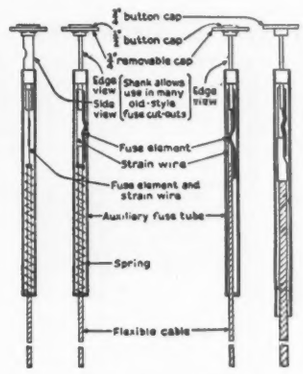
VACUUM CONTACT RELAY

TYPE HBA will close and interrupt a 5½-amp., 250-volt d.-c. circuit ten million times without maintenance. Equipment is inclosed in steel container, and has single-pole, double-throw contacts in heavy-walled evacuated glass tube. Ratings are 15 amp. continuous, 10 amp. interrupting at 115 and 230 volts, 60 cycle and 125 and 250 volts d.c.—*General Electric Co., Schenectady, N. Y.*

OIL-IMMERSED MAGNETIC SWITCH

DESIGNATED as CR7006, this oil-immersed magnetic switch for use in corrosive atmospheres where Class I, Group D control is not required is designed for controlling motors that can be started at full voltage. Consists of standard magnetic switch with special coils and contact tips for operation under oil. Three sizes for various ratings from 3 hp. at 110 volts to 50 hp. at 440 and 600 volts. —*General Electric Co., Schenectady, N. Y.*



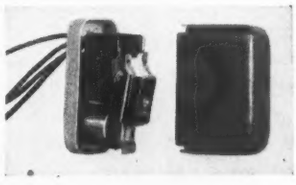


CABLE-TYPE FUSE LINKS

FOR distribution fuse cutouts operating on expulsion principle at 15,000 volts or less. To relieve fusible element of tensile stress, when link is used in indicating or drop-out cutout, strain wire of Monel metal is used in parallel with fusible element. Coordinating charts available. Bulletin. GEA-1816A.—*General Electric Co., Schenectady, N. Y.*

SUPERSENSITIVE RELAY

MODEL 705 makes contact on three micro-amperes or one millivolt and contacts are capable of handling five watts at 110 volts, non-inductive load.—*Weston Electrical Instrument Corp., Newark, N. J.*



SOLENOID CONTROL RELAY

TYPE Hg-15 is for use in copper-oxide rectifiers. Coil operates on d.c. side or rectifier and contacts on a.c. side. Will successfully make and break currents up to 50 amp. at 220 volts. Weighs 2¾ lb.—*General Electric Co., Schenectady, N. Y.*

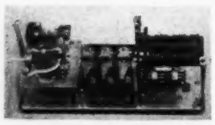
SUPERSENSITIVE RELAY

FOR USE with low-current devices. Operating current 6.0 milliamp. at 6 volts d.c., or 0.0411 and a contact rating of 1,100 watts, give this supersen-

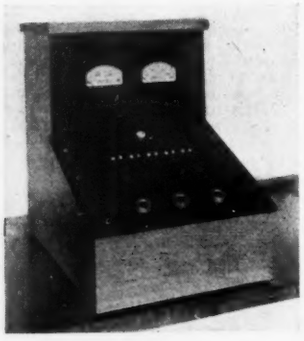
sitive relay high relaying ratio of 24,000:1. Overall dimensions 3⅞x3¼x1⅞ in. Coil rating 875 ohms, 6.9 milliamp., and 6 volts. Contact rating, 10 amp. at 110 volts, or 5 amp. at 220 volts, a.c. In normally open, normally closed, or single pole, double-throw models.—*American Instrument Co., Inc., 774-776 Girard St., N. W., Washington, D. C.*

SYNCHRONIZING RELAY

AUTOMATIC compensation for errors due to source voltage difference and control-voltage variations. Positive and quick-acting. May be used for either



machine synchronizing or line synchronizing, in either automatic or manual stations. Case 5¼x16 in. universal type, with auxiliary box 9½x17 in. behind panel on relay studs. One cable for connections.—*General Electric Co., Switchgear Division, Philadelphia, Pa.*



SMALL SUPERVISORY CONTROL

POLARICODE JR. low-cost control is suitable for industrial plants and combines raise-lower control with simultaneous telemetering indication of position for distant control of valves, rheostats, tap changers, etc. Operates minimum of five apparatus units. Cabinet 14 in. wide, 21 in. deep, 20 in. high.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

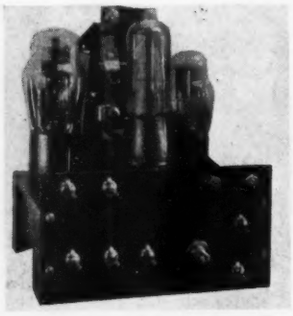
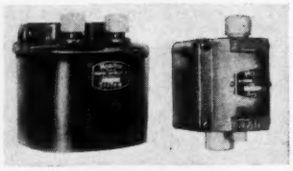


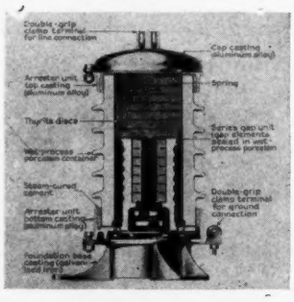
PHOTO-ELECTRIC RELAY

HEAVY-DUTY contactor in "LE" relay interrupts 20-amp., 115-volt, a.c. non-inductive load or 3-amp., 115-volt d.c. Operating speed ranges from 200 to 600 objects per min. Telephone relays eliminated.—*Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.*



PUSH-BUTTON STATIONS

TYPE 9000M (at left) oil-immersed push-button stations for use in corrosive or damp atmospheres. Switch assembly mounted on cover. Type 9000V (right) is heavy-duty weather-proof control station. Quick accessibility to stop button, with start button in protected place. Single-, 2-, or 3-button types and variety of contact arrangements.—*Monitor Controller Co., 75 West St., New York, N. Y.*

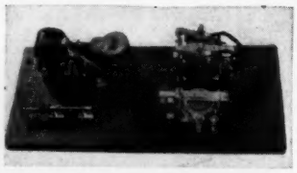

Double-grip clamp terminal for line connection
Cap casting (aluminum alloy)
Spring
Thyrite discs
Series gap unit (gap elements sealed in vit-process porcelain
Double-grip clamp terminal for ground connection

STATION-TYPE LIGHTNING ARRESTERS

FORM D THYRITE station-type lightning arresters. Impulse breakdown voltage of 11.5-kv. unit is about 40-kv. crest. Applying A.I.E.E. standard surge current (1,500 amp.), impulse voltage across arrester unit is limited to only 36-kv. crest, an improvement of 30 per cent over previous designs. Standard 11.5-kv. arrester units interchangeable in arresters of all voltage ratings. Series gap hermetically sealed, metal caps being bottle-cap-crimped over ends of porcelain container, with gaskets permanently locked in position.—*General Electric Co., Schenectady, N. Y.*

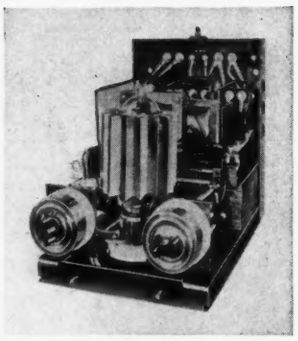
TAPE AND SPLICING COMPOUND

"GOLD SEAL" includes commercial grades as well as special. 1-, 2-, 4- and 8-oz. rolls. Friction tape strong, "tacky," free from pinholes, non-ravelling, high insulating qualities. Splicing compound is high-grade rubber which fuses immediately.—*Jenkins Bros. Rubber Div., 510 Main St., Bridgeport, Conn.*



HIGH-SPEED LOWERING RELAY FOR CRANES

HIGH-SPEED lowering relay for crane hoists increases lowering speed without reducing safety factor or minimizing control accuracy. Controlled by weight. When load is heavier than one-third capacity, relay automatically prevents speed increase. Can be applied to any d.c. motor-operated crane equipped with series motors and dynamic lowering control. Available for hoist motors from 110 to 550 volts.—*Harnischfeger Corp., 4497 W. National Ave., Milwaukee, Wis.*

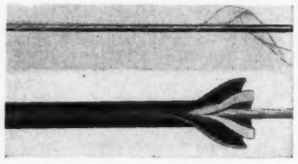


A.C. MANUAL REGULATOR

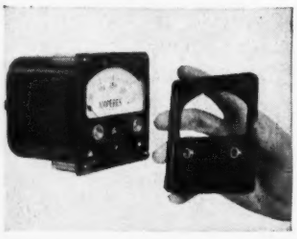
FOR any a.c. circuit where voltage must be manipulated; replaces rheostats, resistances, reactances transformers. Uses Kathetron tube—a hot-cathode rectifier with control grid *outside* the bulb. It acts as an instantaneously operating switch which can be kept closed for a varying time depending upon voltage applied to insulating band around it. Almost any rating desired.—*Roller-Smith Co., 233 Broadway, New York, N. Y.*

CELLOPHANE INSULATION

"CELLOPHANE"-covered magnet wire, and "Duprene"-covered ignition cable. Former, named Celenamel, is produced by wrapping "Cellophane" over adhesive covered magnet wire, then lac-



quering and baking. Increased dielectric strength and about same space factor as silk enameled wire and much less than cotton-covered wires. Ignition cable, called Belden 7799, has special orange rubber compound core and thin jacket of "Duprene," a rubber substitute which resists high heats, hot oil, and decomposing effects of corona.—*Belden Mfg. Co., 4647 West Van Buren St., Chicago, Ill.*



SWITCHBOARD INSTRUMENTS

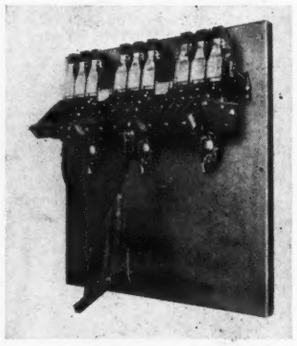
TYPE K complete line of small indicating meters in rectangular cases for a.c. or d.c. Primarily for power station minature switchboards and supervisory control. Movements same as in large instruments, but case is only 4 x 4½ in. Dials illuminated by concealed minature lamps. Mechanism on molded composition sub-base, snap-on front avoids screw-heads.—*Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.*

INSULATING MATERIAL

LAYTEX dielectric is solidified on conductors before they come into contact with any mechanical support, thus centering conductor accurately and giving uniform thickness of dielectric. Tensile strength of dielectric 5,000 lb. per sq.in., elongation at rupture 750 per cent, set in 2-in. gage length 0.25 in. (tests of 65 to 90 deg. F.) Electrical properties: dielectric strength 800 volts per mil, insulation resistance constant 54,000, relative capacity 2.5 (air as unity). These properties permit thinner dielectric wall, making finished conductor lighter in weight and smaller.—*United States Rubber Products, Inc., P.O. Box 12, Station G, New York, N. Y.*

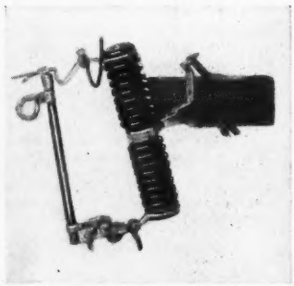
LOW-VOLTAGE CABLE TERMINALS

"STANDARD" line of low-voltage solid-filled cable terminals suitable for use on single-conductor insulated cables rated at 34.5 kv. or less. Terminals for use on paper or varnished-cloth insulated lead-covered power cables of all conductor sizes 2,500,000 circ.mills and smaller.—*General Electric Co., Schenectady, N. Y.*



HEAVY-DUTY CIRCUIT BREAKER

TYPE HD air breakers rated 5 to 10,000 amp., 750 volts a.c., 600 volts d.c. live or dead front, steel enclosed. Will carry rated current continuously with temperature rise not over 20 deg. C. on contacts. Will open circuit at highest speed so far possible with air-type breaker. Interrupting capacity 120,000 amp. with current 5,000 amp. or greater.—*Roller-Smith Co., 233 Broadway, New York, N. Y.*

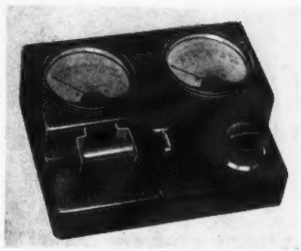


OPEN FUSE CUTOUT

INCORPORATES drop-out feature. Two voltage ratings, 7,500/12,500Y and 15,000 volts. Both can be used from one to 60 amp. and have 1,200 amp. interrupting capacity.—*General Electric Co., Schenectady, N. Y.*

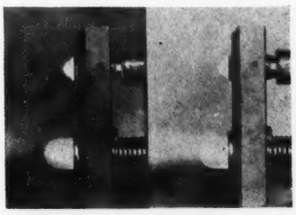
INDICATOR FOR FUSES

PORCELAIN plug and cartridge cutouts with neon lamp indicators. When a fuse blows, neon lamp glows, quickly identifying blown fuse.—*L. S. Brach Mfg., 80 Duryea St., Newark, N. J.*



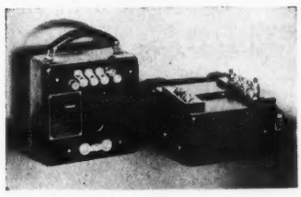
SURGE-CREST AMMETER

FOR use with magnetic-link method of measuring magnitude and polarity of lightning surge currents. Ammeter measures degree of magnetization of links after current passes, and is combination of a milliammeter by which current through combination is read, other a milliammeter without a magnet, so constructed that magnetized link becomes magnet of instrument. —*General Electric Co., Schenectady, N. Y.*



INDICATING LAMP

CAN BE used for signal-light indication or in combination with control switches. Indicating resistor of vitreous-enamel type, receptacle and escutcheon of insulating material. 24-volt lamp and color cap. Illustration shows old and new style with new type above.—*General Electric Co., Schenectady, N. Y.*



PORTABLE CURRENT TRANSFORMER

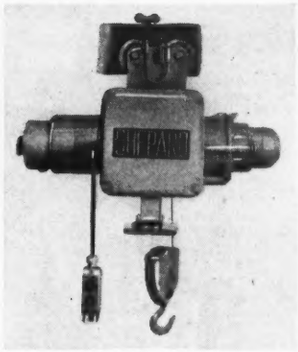
FOR use with indicating and recording instruments. Each transformer has nine primary current ranges of 10, 12½, 25, 50, 100, 160, 200, 400 and 800-amp. capacity. Secondary capacity, 5 amp. Volt-ampere rating is 25, and transformers are compensated for a load of 15 volt-amp. Insulated for use on voltages up to 2,500. Provided with built-in, secondary short-circuiting switch. — *Esterline-Angus Co., Indianapolis, Ind.*

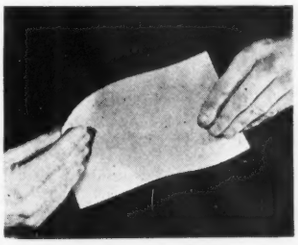
ELECTRICAL METALLIC TUBING

INNER surface covered with small round knobs. These reduce surface friction 30 per cent. No threading in installation; cutting and bending easy. Called "Electrunite Steel-tubes;" bulletin.—*Electrical Div., Steel and Tubes, Inc., 224 East 131st St., Cleveland, Ohio.*

5-SPEED PUSHBUTTON HOIST CONTROL

FIRST speed is "creeping," others progressively to full speed can be felt as distinct points as single button is depressed. When button is released gradually, same series is gone through in reverse order. On heavy loads, fewer speeds are available. Load can be "jogged" between two points where lower point will not keep load lifting and upper is too fast. Two sizes: Class 1, 3 hp., Class A, 7½ hp.—*Shepard Niles Crane & Hoist Corp., 588 Schuyler Ave., Montour Falls, N. Y.*



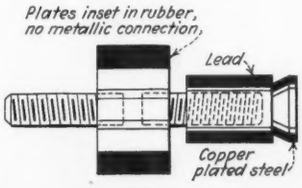


SEPARATORS FOR STORAGE BATTERIES

EXIDE-IRONCLAD Batteries now have separators of Exide Mipor (Reg. U. S. Pat. Off.) a form of vulcanized rubber in sheets, permeated with countless microscopic passages permitting free diffusion of electrolyte. Even minute solid particles of active material cannot pass through. These separators are not affected by electrolyte, are immune to heat developed in a battery. Withstand vibration.—*Electric Storage Battery Co., Allegheny Ave. & 19th St., Philadelphia, Pa.*

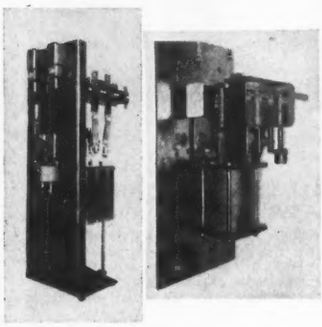
TEST PLIERS

COMBINATION tool extracts fuses (up to 200 amp.) tests open circuits (70- to 250-volt) blown fuses, base receptacles, grounded fixtures, etc. Bakelite and fiber. Testing device is carbon lamp in series with 1,600-ohm resistance. Moisture or high-resistance leak in panel will not light lamp.—*Star Fuse Co., Inc., 168 Centre St., New York, N. Y.*



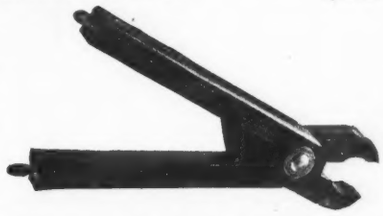
SOUND-ISOLATING BOLT

"SOUND-STOPPER" comprises two elements, anchor and double stud with sound-isolating insert. Anchor is similar to expansion bolt of permanent type. Double-stud unit comprises two studs in plates joined by vulcanized rubber cylinder, no metallic contact between stud ends. Machine is set on insulating board around sound-stopper unit and bolted to top half. This puts sound-stopper in tension and provides sound-isolating mounting. Variety of sizes.—*Walter J. Ottinger, 1893 East 55th St., Cleveland, Ohio.*



SELF-SUPPORTING PANELS FOR SMALL CIRCUIT BREAKERS

SUITABLE for use on ungrounded systems up to 2,500 volts. Oil circuit breaker interrupting ratings are 20,000 to 50,000 kva. Requires no assembly of apparatus or adjustment of breaker or mechanism. Consists of isolated flanged steel panel, to which supporting feed have been welded. In addition to breaker and operating lever, accessory apparatus, such as current transformers, relays, etc. can be mounted.—*General Electric Co., Schenectady, N. Y.*



FUSE PULLERS & TEST LIGHT

COMBINATION tool. Test pins mounted on handle ends. Test light inclosed in handle. Reinforced Bakelite, for handling fuses from 30 to 100-amp. and for testing circuits of 110 to 500 volts. Overall length, 7 in. —*Ideal Commutator Dresser Co., Sycamore, Ill.*

COIL WINDER

"IDEAL" coil winder can be used for making motor, armature, field, transformer and other types of coils with diamond, round, square or rectangular cores. No wearing parts, and form tubes may be removed instantly from finished coils. Face plate is of welded steel, which can be fitted to any lathe head easily. Diamond coils made in series of any number up to eight.—*Ideal Commutator Dresser Co., Sycamore, Ill.*

TRIP-FARE SOLENOID MECHANISM

TYPE MS-5 has potential trip coil for remote tripping, also provision for three instantaneous or time overcurrent trip coils. Current trip coils, when energized release mechanism by direct-acting trip mechanism to open breaker. Emergency manual operation by removable lever. — *General Electric Co., Schenectady, N. Y.*

RECTANGULAR SWITCHBOARD INSTRUMENTS

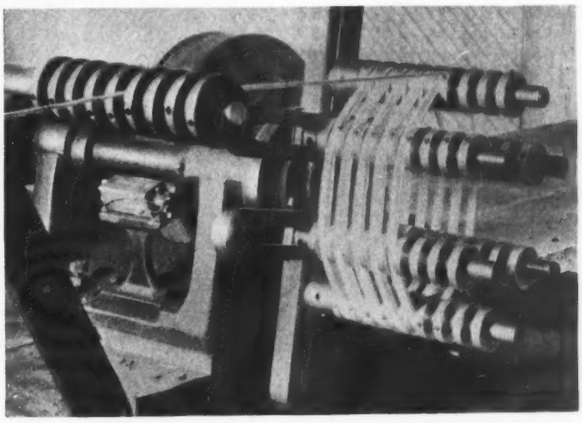
SCALE can be read at an angle without error of parallax. Anti-glare glass, magnetic damping, high torque, responsiveness, permanently constant, characteristics and three styles of cases. Types AD-6 and DD-6 include a.c. voltmeters, ammeters, wattmeters, P.F. meters and frequency meters, and d.c. ammeters and voltmeters. Also special instruments, surface (6x5¼ in.) and flush (7x6¼ in.) types and 3-element types 12x5¼ in.—*General Electric Co., Schenectady, N. Y.*

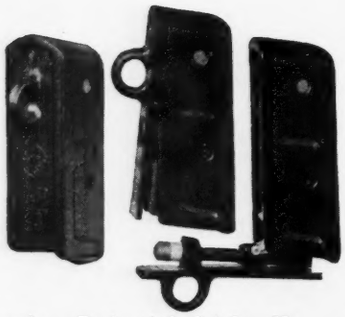
SPLASH-PROOF INDUCTION MOTOR

SPLASH, weather- and drip-proof special cast frame and end brackets and cast conduit box. Baffle plate cast integral with inner side of motor bracket. Ball or sealed sleeve bearings. Squirrel-cage and wound-rotor types. —*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

INCLOSED INDICATING AND DROP-OUT FUSE CUTOUT

PORCELAIN-INCLOSED. Door bottom protrudes only 1¼-in. when fuse link is blown, thus protects live contacts and mechanism from weather. Rated at 5,000 volts, 60 amp., with interrupting capacity of 1,500 amp. (R.M.S.) easily convertible from indicating action to drop-out action by lifting out small wire





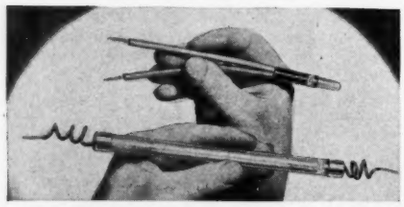
yoke. Designated Catalog No. 9F6A1. Bulletin GEA-1993.—*General Electric Co., Schenectady, N. Y.*

PLUNGER-TYPE RELAY COMPOUND

COMPOUND can be used for new relays or in place of leather bellows in older units. Gives greater reliability and longer life and requires no oiling or dressing.—*General Electric Co., Schenectady, N. Y.*

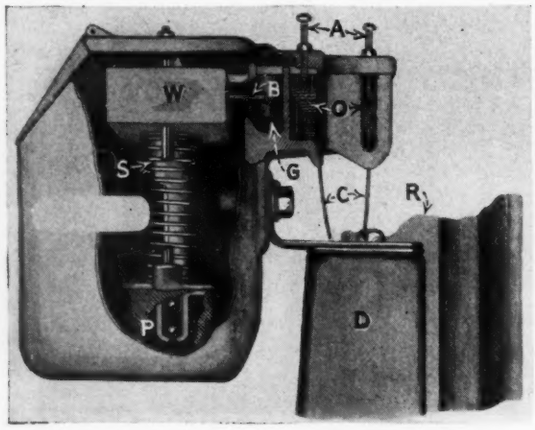
VOLTAGE "FUSES"

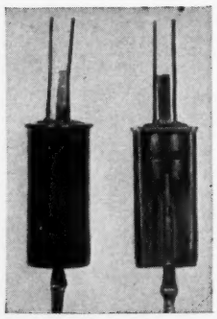
"TATTELITES" are neon discharge tubes with breakdown potentials of 100, 250, 500, 1,000 and 2,000 volts which will protect equipment against excessive voltages just as regular fuses protect against excessive currents. They operate by shunting out overloads. Pages 9 and 10 of Catalog No. 6.—*Littlefuse Laboratories, 1772 Wilson Ave., Chicago, Ill.*



GUIDE-RAIL LUBRICATION OF IMPULSE TYPE

USES oil pumped to auxiliary reservoir from which it flows to rail under close regulation *P* is inertia-type pump operated by weight *W*, supported on spring *S*. Any sudden car movement, such as start or stop, causes weight to move up and down and operate pump: oil is delivered through pipe *B*, into groove *G*, leading to three chambers *O*, one for each wearing surface of guide shoe. Wire conductors *C* carry oil in drops to a groove adjacent to rail *R* around top of guide shoe *D*. Oil flow regulated by *A*.—*A. B. See Elevator Co., Inc., 419 Fourth Ave., New York, N. Y.*





ALL-METAL VACUUM SWITCH

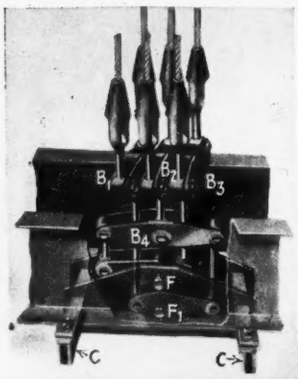
MADE almost entirely of steel and designed to take advantage of absence of an arc when breaking a circuit in high vacuum, these vacuum switches are only ⅝ in. in diameter and 1½ in. long. Operated by a fraction of an ounce pressure, unit can interrupt as much as 5 hp. as fast as 30 times per sec. Designated as Type Fa-6 and rated at 10 amp., 250 volts d.c. or 440 volts a.c. or 5 amp. at 500 volts d.c.—*General Electric Co., Schenectady, N. Y.*

WEATHERPROOF OUTLET

THIS outlet has flush plate with solid rubber pad on back, insuring snug fit. Cap slips over cord plug and screws onto plate. Another rubber-insulated cap, chained to flush plate, screws over outlet when not in use.—*General Electric Co., Schenectady, N. Y.*

ELEVATOR-ROPE EQUALIZER

SPECIALLY designed roller bearings. In six-cable design shown, ropes connect to ends of three equalizing bars B_1, B_2, and B_3. Bar B_2 connects to center of equalizing bar B_4. Ends of this bar connect to one end of each of two other equalizing bars fulcrumed at F and F_1. Bar B_1 connects to one end of bar fulcrumed at F_1 and B_3 to bar fulcrumed at F. Equalizing equipment is attached to plates by fulcrum shafts F and F_1 and these plates support car by two bars C that pass through them under car's crosshead. Ropes are thus free to equalize load between them.—*L'Code Corp., subsidiary A. B. See Elevator Co., 419 4th Ave., New York, N. Y.*



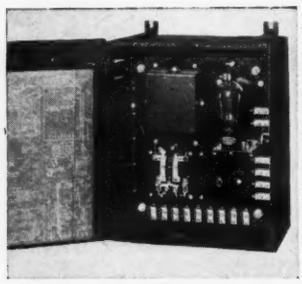
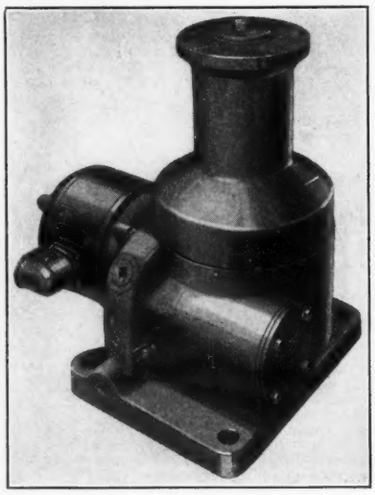
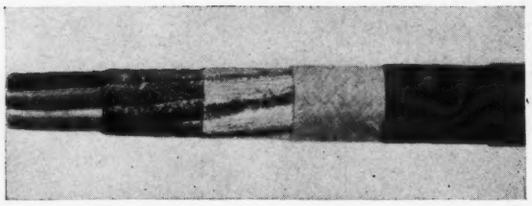


PHOTO-ELECTRIC CONTROLLERS

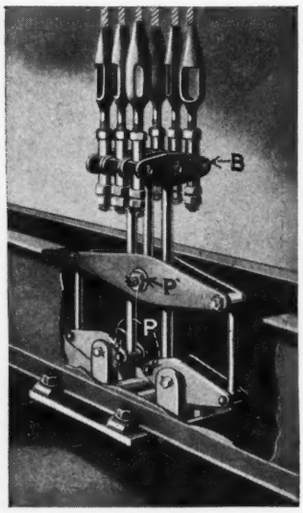
ACTUATING impulse need be only 1/5000 sec. and from phototube, delicate contact or control circuit. Units to maintain response indefinitely or for adjustable predetermined length of time. Either increase or decrease in illumination may be used to cause tube to pass current. Maximum number of operations for electronic equipment is 5,000 per min. Each unit comprises panel assembly on which are mounted tube sockets, transformers, resistors and other parts in cabinet.—*Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.*





FIREPROOF CONTROL CABLE FOR ELEVATORS

COVERING is a specially treated fibrous, first-resistant and moisture-proof sheath. Conductors made up of fine copper strands insulated with 30 per cent rubber.—*A. B. See Elevator Co., Inc., 419 Fourth Ave., New York, N. Y.*

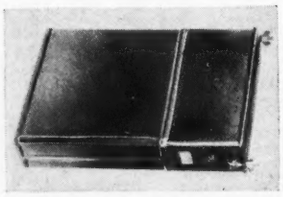


LEVER-TYPE EQUALIZER FOR ELEVATOR ROPES

PIVOTED whiffle-tree levers distribute loading and rope stretch takeup. This action gives load centering with no tendency to crowd either guide rail. Equalizer for six ropes shown.—*A. B. See Elevator Co., 419 Fourth Ave., New York, N. Y.*

MOTORIZED CAR SPOTTER

VERTICAL-CAPSTAN type electric unit with motor attached to side of housing. Housing includes helical-gear reduction at motor and worm-gear set, running in oil. Two sizes, smaller with pull of 5,000 lb., larger 10,000 lb. —*Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill.*



CAPACITOR

TOTALLY inclosed non-inflammable capacitor treated and filled with Pyranol which is non-inflammable and has high insulating and dielectric properties. Dielectric itself is hermetically sealed, and connections are brought out through bushings into dust-tight box on top, provided with conduit holes.—*General Electric Co., Schenectady, N. Y.*

OIL FILTERS, PURIFIERS, LUBRICATORS, LUBRICANTS

LUBRICATOR

MODEL ET totally enclosed lubricators are available in either sight-feed (Type BF) designs, both using single-plunger principle. Single plunger takes oil from reservoir, measures it and forces it to delivery point. Plunger actuated by rocker arm traveling on an eccentric. Rocker arm drives plunger in straight line, thus avoiding wear due to side thrust. Exact amount of oil passed to sight-feed is delivered at each stroke. Adjustment from one to ten drops per stroke against varying pressures up to 2,000 lb. Regulation by changing length of stroke. Glycerine or blinker sight-feeds or pump-plunger stroke-length indicator available. Clutch drive. All working parts run in oil. Reservoir capacities 2 to 8 points.—*Hills McCanna Co., 2349-59 Nelson St., Chicago, Ill.*

BARREL RACK

"ROCKERACK" permits one man to put drums and barrels into convenient position for draining. Uses new arrangement for tilting and lifting that is easier, quicker, safer. Two styles, Model 18 without casters, 18W with casters. Handles any barrels or drums of 30 to 55 gal.—*Barrett-Cravens Co., 3255 West 30th St., Chicago, Ill.*

SPECIAL MINERAL OILS

"STA-PUT" lubricants improved by addition of hydro-carbons which increase load-carrying capacity.—*E. F. Houghton & Co., 240 W. Somerset St., Philadelphia, Pa.*

GRAPHITE LUBRICANT

IDEAL "Kant-Rust" penetrating graphite lubricant is available in eight different sizes of containers, from 3-oz. handy can to 55-gal. drum. Used to release pulleys, Woodruff keys, rusty nuts and bolts, expansion taps and dies, and to prevent rust and corrosion.—*Ideal Commutator Dresser Co., Sycamore, Ill.*

LUBRICATOR

1,000 SERIES VICTOR automatic force-feed lubricator has cadmium plated steel body. New sight feed shows reservoir supply as well as rate of feed. Larger filler tube. New valve control inside filler tube. Airtight.—*Victor Lubricator Co., 368 N. Michigan Blvd., Chicago, Ill.*

GREASE CARTRIDGE

1-LB. factory-loaded grease cartridges have sliding bottoms which act as plungers to feed grease or oil into high-pressure chamber in gun nose. Cartridges may be interchanged when different type grease is required, since both base and head seal. Non-refillable. — *Lubrication Corp., 910 S. Michigan Ave., Chicago, Ill.*

HEAVY-DUTY GEAR LUBRICANTS

THIS 600 series will withstand from 3 to 5 times the load that straight mineral oils of same type, without these characteristics, will withstand. Torque readings show friction reduction of 30 to 50 per cent as compared with same oils before treatment. —*E. F. Houghton & Co., 240 W. Somerset St., Philadelphia, Pa.*

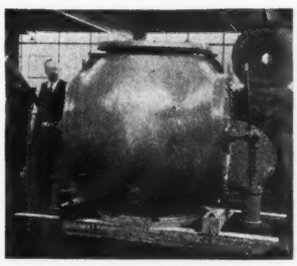
GRAPHITE LUBRICATION

"GRAPH-AIR GUN" was designed for applying "Microfyne" flake graphite. Gun is rubber, and when squeezed deposits graphite where needed in measured amounts through positively controlled air pressure. Nozzle may be shut off, making gun practical to carry in tool kits. Standard nozzle 2 in. but 8-in. nozzle may be secured.—*Joseph Dixon Crucible Co., Jersey City, N. J.*

PIPING, VALVES AND FITTINGS

IRIS SHUTTER VALVE

HAND or power operation, piston or motor driven, and can be set for a position orifice to give measured flow of gas or air. Sizes from 1-in. to 72-in.—*York-Lalor Division, York Oil Burner Co., Inc., York, Pa.*



VERTICAL EXHAUST RELIEF VALVE

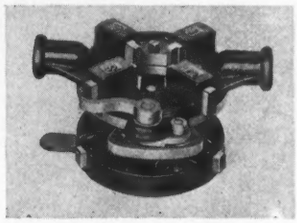
THIS 36-in. valve may be completely disassembled without removing body from pipeline, disk being removable through either of duplicate covers on sides. Through cross-shaft with roller bearings and grease-sealed packing boxes carries two internal cranks attached to disk and two external cranks, one attached to hydraulic lifting cylinder, other to oil dashpot. Two counterweighted levers balance disk and hold it open after it leaves seat. Inlet and overflow connections provided.—*Davis Regulator Co., Chicago, Ill.*

RELIEF VALVE

SIX sizes with two pressure ranges, Model V pressures 5 to 35 lb., Model VH 35 to 100 lb., difference being in springs. Sizes ⅜ to 1¼ NPT. Formed like tee fitting and mountable in any position. Compact assembly. Valve adjustable. Spring compartment vented. Many parts common to several sizes.—*Tuthill Pump Co., 131 West 63rd St., Chicago, Ill.*

PIPE TOOLS

No. 200 Beaver swivel pipe reamer rams ⅛ to 2-in. pipe. Reamer can be resharpened or replaced when worn out. No. 70 and 72 Series diestocks will not mar pipe; have wide range, no loose bushings, and fully adjustable. Each set of dies threads two sizes (except ⅛). Stock malleable iron. No. 70



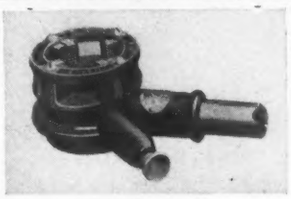
threads either ¼ to 1¼ or ⅛ to 1¼. No. 70 R (ratchet) same ranges. No. 72 series handle up to 2-in. pipe. — *Borden Co., Warren, Ohio.*

LEAD-COVERED PIPE

STANDARD and special straight lengths of thick- and thin-wall pipe of various metals are protected on outside by chemically pure lead, antimonious lead, tin-lead or tellurium-lead in any specified thickness. — *Gross Engrg. Corp., 3955 West 25th St., Cleveland, Ohio.*

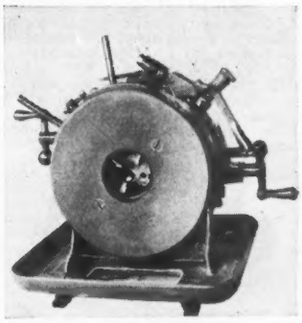
PIPE-WELDING FIXTURE

ALL sizes of pipe to 12 in. lined up accurately and held in position for tacking. Extension bench for longer lengths. Adjustable elevator, usable on main fixture or extension, controls vertical alignment. Elevator supports graduated for accurate angle setting. Main bench weighs 700 lb., extension 300. Main bench I-beam 8 ft. long, 2 ft. high, 1 ft. wide; extension 6 ft. long.—*Oster-Williams, 2057 East 61st Place, Cleveland, Ohio.*



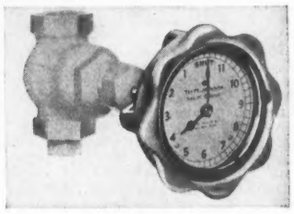
RATCHET THREADING TOOL

No. 11 tool now has capacity of ⅛ to 1¼ in. Separate die head and dies for each size.—*Toledo Pipe Threading Machine Co., Toledo, Ohio.*



QUICK-SETTING DIE HEAD

IN "Red-E-Quick" and "Double-Quick" die heads quick die-setting is accomplished by drawing up a die-controlling cam ring until desired one of a series of notches, representing various thread sizes, is engaged by a pawl. Only two sets of dies required to thread all sizes of pipe from ⅛ to 2 in. In "Double-Quick" die head illustrated, two sets of dies are so arranged that operator can select and set one or other without die changes. —*American Die & Tool Co., Reading, Pa.*

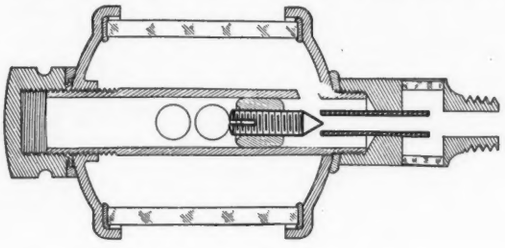


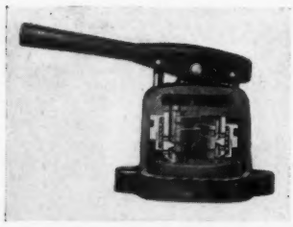
VALVE-POSITION INDICATOR

REPLACES valve wheel, tells at a glance whether valve is open or shut, or what proportion open. Standard indicator wheel diameter 4½ in., special sizes to order.—*Tefft-Jackson, Inc., 120 Main St., Providence, R. I.*

MANIFOLD VALVE

ADAPTABLE where several valves must be close together. Between reversals, valve disk rotates on two eccentric points. Disk and seat wear uniformly across full diameter. — *Hanna Engrg. Works, 1765 Elston Ave., Wicker Park Station, Chicago, Ill.*





AIR-OPERATING VALVE

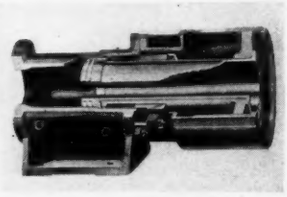
STAINLESS-STEEL or brass cylindrical body is drilled longitudinally from each end, leaving solid section between ends of drill-holes. At base of each hole, and opening into it, eight ports are drilled radially around body. Surrounding this body, a sleeve is fitted, holding at each end a circular "U" leather packing. This sleeve slides freely on valve body. Closely fitted surfaces not required to maintain tightness. Action comparable to piston pump. Includes standard 3- and 4-way actions, as well as various neutral-position and automatic return valves in hand-, foot- and solenoid-controlled types. Bulletin 101-V.—*C. B. Hunt & Son, Salem, Ohio.*

PRESSURE CONNECTION

PRESSURE takeoff permits quick, convenient, tight connection to any pressure line of gage, regulator or other pressure-operated device; also small fluid drip lines. Pipe connection is screwed loosely into top clamp and presses directly against gasket, which in turn presses on pipe. Fluid pressure is transferred through adjustable pilot tube, which is loose in both metal holes but tightly squeezed by gasket. Single clamp gives three-point contact on all pipe sizes ¼ to 1 in.—*Walter J. Ottinger, 1893 East 55th St., Cleveland, Ohio.*

CONDENSATE-REMOVING DEVICE

"DRAINATOR" removes condensate. Gives positive, visual indication that condensate is flowing and shows elimination. Handles entrained air with variable-capacity device. Will operate on any steam pressure up to capacity of metal parts without exchange of parts. Sizes from ¾ to 1¼ in. in range wide enough to accommodate any drainage condition. Bulletin.—*Coe Mfg. Co., Painesville, Ohio.*

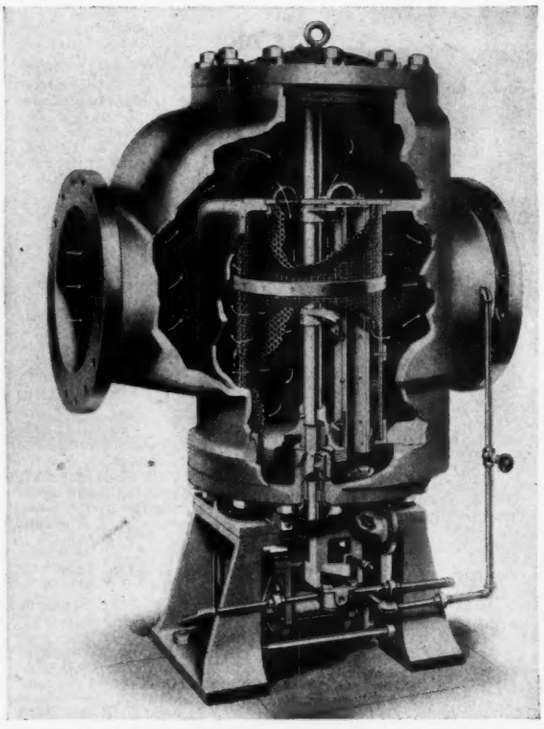


PISTON-RING EXPANSION JOINT

SEVERAL improvements, ranges now being 125 lb., 250 lb. and 400 lb. Non-corrosive gland studs and nuts. Leaflet 234.—*American District Steam Co., North Tonawanda, N. Y.*

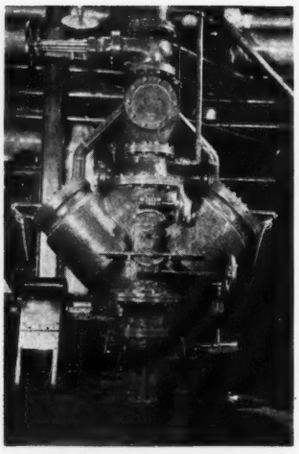
SELF-CLEANING STRAINER

WILL clear service water of extraneous matter down to quite small particles, yet does not need frequent cleaning. Self-cleaning mechanism operated by self-contained water motor taking water from outlet side of strainer. Water flow shown by white arrows; black arrows show back-washing action which carries dirt down hollow scraper and out to drain. Strainer basket made up of three thicknesses of perforated plate or mesh. Inside is plate ¼ in. thick with round perforations, outside is No. 3 mesh wire frame, with No. 28 Monel-metal wire cloth (0.02-in. openings) between. Sizes from 4 to 24 in., for 125-lb. working pressure.—*Elliott Co., Jeanette, Pa.*



SELF-CLEANING STRAINER

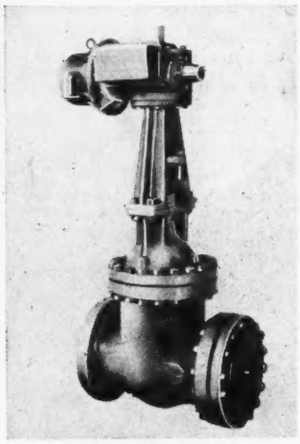
PHILLIPS strainer has back-washing feature to permit cleaning of strainer while in operation and without removing baskets. Comprises two baskets at 90 deg. to each other, flow of liquid being controlled by two strainer in reverse direction, thus flushing debris through bypass valve. Swing-gate valve is then reopened.—*Henry Pratt Co., 2222 S. Halsted St., Chicago, Ill.*



ELECTRIC VALVE OPERATOR

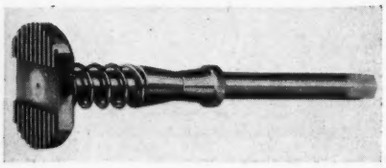
"LIMITORQUE" valve operator has control consisting of self-contained reducing gear unit with mechanical and electrical limit built in. Valve-operating nut that releases and lowers valve disk is incorporated in casing and supported by heavy-duty Timken roller bearing 1,800-r.p.m. motor is first reduced by low-ratio helical gear, then by steel-and-bronze worm gear. Entire mechanism immersed in oil. Every moving part inclosed. Three sizes which, with two motors per frame, permit six combinations. Valves of 3 to 72-in. diameter are operable by these units, and sizes from 3 to 24-in. are capable of pressures up to 600 and 1,000 lb. per sq.in. Unit is adaptable to every form of gate and globe valve, sluice gates, dampers, or other mechanism also to hand-operated valves. No external gears. Hand operation by simply attaching hand wheel to extended shaft. Bulletin.—*Philadelphia Gear Works, 330 West 42nd St., New York, N. Y.*

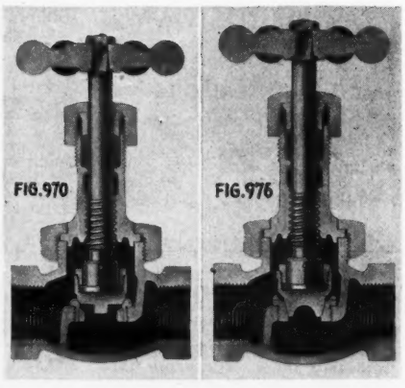
swinging gate valves. Strainer baskets are perforated cylinders, open at both ends. Water, entering at bottom, divides, half passing through each basket. When one basket is to be cleaned, bottom gate valve is closed, cutting off inlet water. By-pass quick-opening valve on that basket is then opened and closed quickly two or three times to force clean water through



VALVE RESEATER

"JIFFY" resurfaces flat globe valve seats while connected in line. Spring provides pressure for cutting blades. Automatically centered.—*Hutton & Jenks, Bancroft, Ia.*



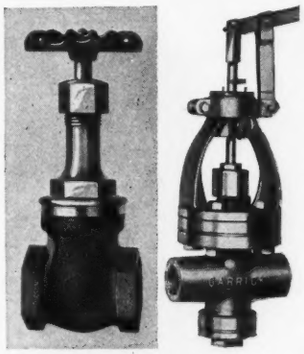


EXTRA-HEAVY BRONZE VALVES

THESE regrind-renew valves made in globe and angle patterns. Figs. 970-973 fitted with nickel alloy seat ring and disk; Figs. 976-979 with nickel-alloy seat ring and plug (for throttling or extremely severe service). All valves union bonnet type in sizes to 2 in. In 2½- and 3-in. sizes, valves have bolted bonnet. Screwed-end valves recommended for 300-lb. steam and 500-lb. oil, water and gas. Flanged-end valves for 250 lb. steam and 400-lb. oil, water or gas. Stuffing boxes very deep, using lubricated and graphited asbestos packing. Bronze gland or follower. Bodies electric furnace bronze. Supplement to Jenkins Catalog 23.—*Jenkins Bros., 80 White St., New York, N. Y.*

BRONZE GATE VALVES

INSIDE-SCREW, traveling-spindle gate valves with screwed and flanged ends, for various working pressures. Figs. 47 and 48 for 125-lb. steam or 200-lb. oil, water or gas. Figs. 49 and 50 handle 150-lb. steam or 225-lb. oil, water or gas. All bonnet threads in contact with spindle at all times. Body cast bronze. Extra-deep stuffing box. Valves can be repacked under full pressure and fully open. Supplement to Catalog 23.—*Jenkins Bros., 80 White St., New York, N. Y.*

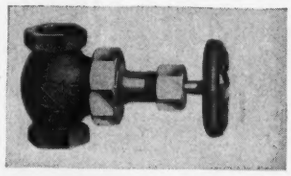


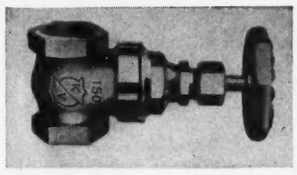
FLOW-CONTROL VALVE

CARRICK Type FT No. 1 adjustable Flow-Trol valve is moving-plug type. Valve body and all external parts except lever are cast hard bronze for usual steam conditions. For high steam conditions, body and head flange cast steel. Other external parts gray cast iron. Operating lever always Monel and stem stainless steel. Screwed connections standard, but flange connections available. — *Carrick Engrg. Co., P. O. Box 299, Michigan City, Ind.*

GLOBE AND ANGLE VALVES

FEATURE is cadmium plating of malleable-iron union bonnet ring and stuffing box nut. Bronze-to bronze union joint between body and bonnet. Can be repacked under pressure. Sizes from ¼ in. to 3 in., suitable for 150-lb. working steam pressure and 250-lb. working water pressure.—*Kennedy Valve Mfg. Co., Elmira, N. Y.*



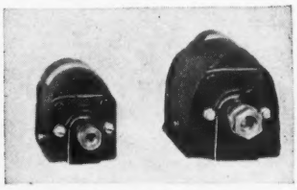


HEAVY STANDARD BRONZE GATE VALVE

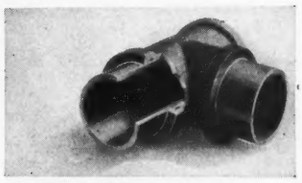
DESIGNED for 150-lb. working steam pressure and 250-lb. working water, oil or direct gas pressure, this valve, known as Fig. 23, has all features originally incorporated in Kennedy Fig. 27 standard unit, but is heavier throughout. Deep stuffing box with graphite molded packing rings, bronze gland and heavy packing nut. Non-heating, non-slipping hand-wheel and heavy pipe-end hexes. Sizes up to 3 in.—*Kennedy Valve Mfg. Co., Elmira, N. Y.*

FLUID VALVE

THIS electrically operated fluid valve handles small or large volume. Energizing oil through pushbutton allows fluid to flow

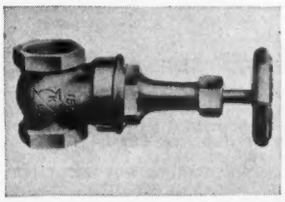


to operate a whistle or other device. Or coil may be engaged continuously to hold valve open, and should power to circuit fail, valve closes automatically. Three sizes. — *Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*



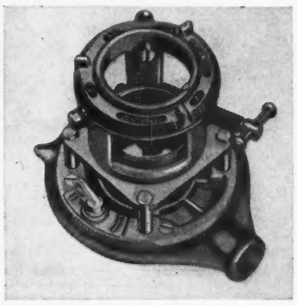
THREADLESS BRONZE FITTINGS

"WALSEAL" fitting has Sil-Fos rings of brazing alloy in each opening. Pipe is inserted and joint heated with oxy-acetylene flame until brazing alloy flows out and seals joint. Will not clog joint, but has enough alloy for two joinings. Made for extra-heavy pipe.—*Walworth Co., New York, N. Y.*



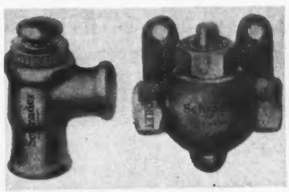
RISING-STEM HEAVY BRONZE GATE VALVES

FIG. 45, companion to Fig. 23 with stationary stem, is for 150 lb. working steam pressure and 250 lb. working water, oil or gas pressure. Operating mechanism employs solid-wedge disks without small, quick-wearing parts. Flexible connection between disk and stem. Deep stuffing box. —*Kennedy Valve Mfg. Co., Elmira, N. Y.*



POSTER THREADER

"RIDGID" threader threads 1, 1¼, 1½ and 2-in. pipe. Rustproof. Four sets of chasers, one for each size, but interchangeable. Locked-in chasers, ratchet for forward, reverse or lock.—*Ridge Tool Co., Elyria, Ohio.*

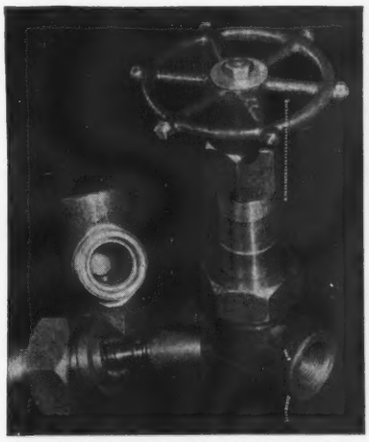


COMPRESSED-AIR VALVE CONTROLS

AT left is Schrader No. 7796 industrial blow valve with standard ¼-in. female tapered I.P. threads. Can be set up for hand or foot control or with intermittent blast device. At right is No. 7854 for heavy-duty work. May also have lever operating from one of holding-bolt holes. —*A. Schrader's Son, Inc., Brooklyn, N. Y.*

GASKET-TYPE PIPE COUPLING

CHAMPION drop-forged positive-seal pipe coupling makes possible joining of straight plain-end pipe without grooving, threading, beveling or upsetting ends. Tensional strength greater than that of threaded joint. Gasket seal has been tested up to 4,000 lb. per sq.in.—*Champion Machine & Forging Co., Cleveland, Ohio.*

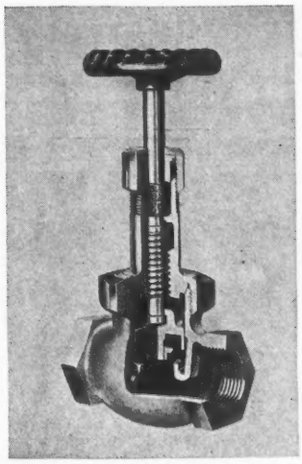


FORGED STEEL VALVE

SIMILAR in straight-line flow to gate valve. Disk is truncated cone swiveling on stem end. Sizes ¼- to 1-in. rated for 2,500 lb. hydraulic pressure at room temperature and 600 lb. w.s.p. at 750 deg. F.—*Edward Valve & Mfg. Co., Inc., East Chicago, Ind.*

GLOBE AND ANGLE VALVES

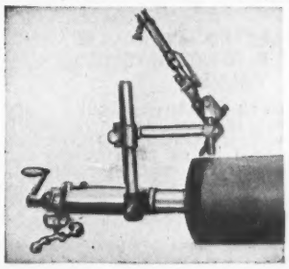
RENEWABLE bronze. Radial seat between body and bonnet for tight joint alignment and longer wear. Seat drawn to tight joint by union nut without sliding or scraping of seat surfaces. Long-fiber asbestos disk ring, standard for interchangeability with



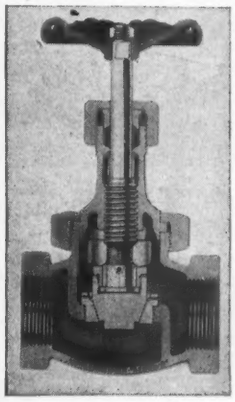
other types if desired.—*Fairbanks Co., 393 Lafayette St., New York, N. Y.*

OXY-ACETYLENE PIPE-CUTTING MACHINE

OXWELD pipe-cutting and beveling machine consists of center rod with three spreading arms which press against pipe inner wall, holding it in position, with an arm supporting a torch that can be adjusted to desired angle.



—*Linde Air Products Co., 30 East 42nd St., New York, N. Y.*

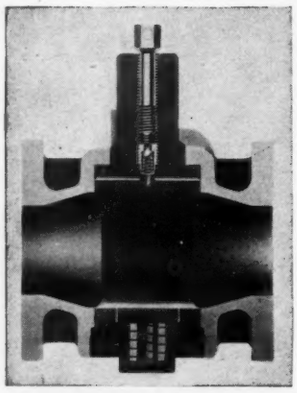


PLUG-TYPE VALVES

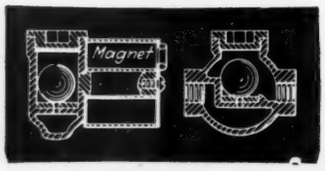
IRON body, bronze mountings (Ferrenewo) for 150 lb. S.P., bronze (Renewo) in 200-lb. and 300-lb. S.P. patterns. Except for bodies and rings, parts interchangeable. Booklet 541-A.—*Lunkenheimer Co., Cincinnati.*

LUBRICATED-PLUG VALVES

WELL-PROPORTIONED, roundcornered full-pipe-area port opening, short lubricant passages, large metal-to-metal head and properly lubricated and sealed line seats. No auxiliary packing. When lubricant pressure becomes too high, it discharges around neck of plug. In 125-lb. or extra-heavy 250-lb. lubricated

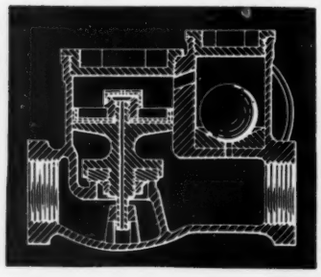


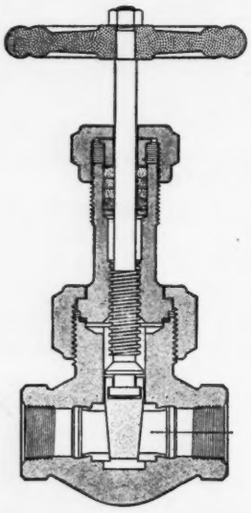
valves with screwed or flanged ends, wrench and gear operated. Also 150-lb., 2-port and 3-way units. Standard sizes. Circular No. 51.—*American Car & Foundry Co., Valve Division, 30 Church St., New York, N. Y.*



ELECTRO-HYDRAULIC AND ELECTRO-MAGNETIC VALVES

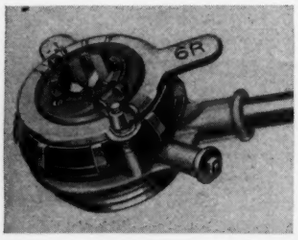
HOPPE electro-hydraulic valve uses 16 watts per hr. Can be used wherever stop valve is needed or as pressure-reducing valve for steam. Pressures to 250 lb., sizes ¼ to 1 in. Line pressure opens and closes unit. Also electro-magnetic unit similarly used, although only ¼-in. size is now available. For remote control of fluid lines. When magnet is energized, it rolls ball horizontally from seat. —*Myers Engrg. Equipment Co., Mart Bldg., 501 S. 12th St., St. Louis, Mo.*





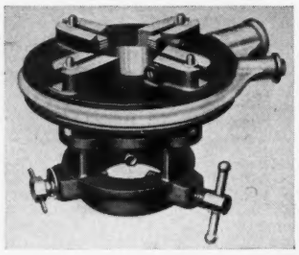
DROP-FORGED STEEL GATE VALVE

INSIDE-SCREW stem has union bonnet with either gasket or ground joint as desired. Sizes ¼ to 2 in. Oil or steam service up to 600 lb. at 800 deg. F., or non-shock cold working pressures up to 1,500 lb. May be repacked under pressure. Stainless-steel. Nitralloy or Monel-metal trimmings to suit service. Also several other new types.—*Henry Vogt Machine Co., Louisville, Ky.*



DIESTOCKS

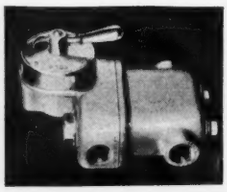
No. 6-R BEAVERETTE ratchet stock is a "one-piece" unit capable of threading ¼- to ¾-in. pipe without changing dies or bushings. Close nipples can be cut. Two sets of dies always in tool —because of difference in pitches. Right- or left-hand, ¼-in. dies on order. No. 38-R



Beaver ratchet for 8-thread, 2½- or 3-in. pipe. Straight-line pull. Separate dies for each size. Interchangeable die segments. Right-hand only.—*Borden Co., Warren, Ohio.*

PIPE AND BLOCK INSULATION

RESISTANT to moisture, this packing simply dries out unharmed. High efficiency saves thickness in installation. Easily cut, light, non-sagging and non-crumbling. Standard molded-type shapes and sizes.—*Refractory & Engrg. Corp., 381 Fourth Ave., New York City.*



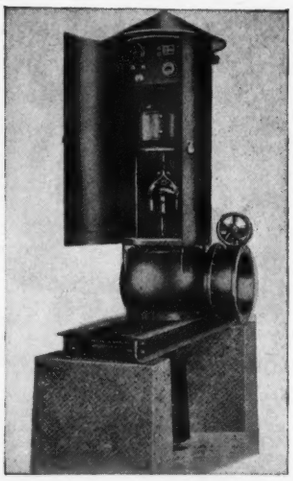
WATER MIXING VALVE

No. 904 is thermostatic type usable either as maximum temperature limiting device in hot-water line and auxiliary mixing valve, or alone to give accurately controlled hot water temperature set manually. If cold-water supply fails, mixer shuts off hot water also.—*Fulton Sylphon Co., Knoxville, Tenn.*

top and retained against floating by steel shaft carrying adjustable thrust washer and jam nuts. Single or double baskets with perforations for fuel, lubricating or diesel oils. Ratio of free-straining area 4½ times pipe cross-section with single baskets, 8½ times with double. Working pressures up to 350 lb.—*Staples & Pfeiffer, Ltd., 528 Bryant St., San Francisco, Calif.*

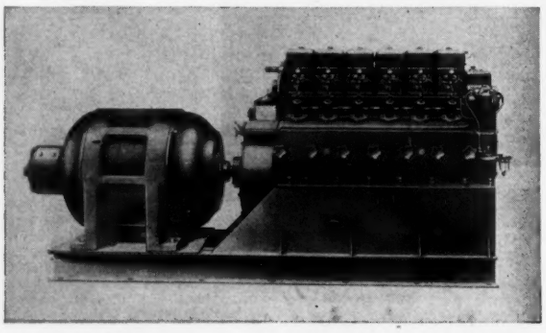
HYDRO-ELECTRIC PLANT

COMPLETE self-contained unit for a.c. as well as d.c. and with complete ball-bearing mounting of revolving parts. Proper



combination of turbine, governor and generator. Automatic; suitable for 24-hr. service. Standard capacities ½ to 5 kw., voltages 32, 125 to 250. Larger units or special designs by order.—*Hoppes Water Wheel Co., Springfield, Ohio.*

STEAM, OIL AND GAS PRIME MOVERS AND AUXILIARIES



4-CYCLE DIESEL

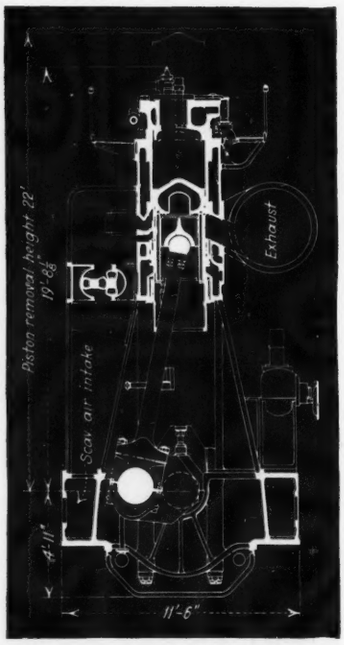
AVAILABLE in 1-, 2-, 3-, 4- and 6-cyl. sizes, with capacities of 10, 30, 40 and 60-b.hp. 4½x6-in. cyl.; normal operating speed 1,200 r.p.m. Displacement 85 cu.in. per cyl. and 5.370 cu.in. per min. per hp. at rated speed. Cylinders enbloc. Removable cylinder liners. Cylinder heads water-jacketed. Injection timing control. Lubrication force feed throughout. Cooling water circulated by reciprocating plunger-type pump driven from camshaft at half engine speed. Fuel pumps of individual mechanical-injection type with fixed stroke and variable inlet cutoff, mounted directly beside each cylinder, with short, equal length connections to nozzles. 4-, 5- and 6-cyl. units fitted with complete electric starting systems. For electric generating services, engines are available with either a.c. or d.c. generators, in capacities of 6 to 40 kw. —*Fairbanks, Morse & Co., 900 S. Wabash Ave., Chicago, Ill.*

SILCHROME EXHAUST VALVE

FOUR times usual life. Silicon-molybdenum seated "Sili-seat" exhaust valve. Body molybdenum-steel forging.—*Meriam Co., 1955 West 112th St., Cleveland, Ohio.*

DUPLEX STRAINER

S&P DUPLEX strainers have double valve plug inserted from



TRUNK-PISTON DIESELS

LARGEST trunk-piston diesel so far built, this unit follows design of company's 19½x27-in., 2-cycle, single-acting engine. In units up to 12 cyl., with rating of 10,000 b.hp. Low piston dismantling height. Separate piston-pin housing provides full-length bearing for pin. Scavenging air supplied either by an independent turbo-blower or

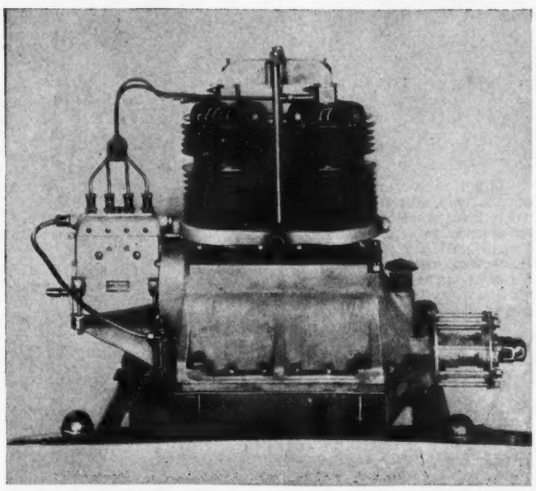
Busch-Sulzer positive-displacement rotary blower. Fuel consumption per gross b.hp.-hr. runs between 0.335 and 0.347 lb. Cross-section is of 30x52-in. unit, rated 750 b.hp. at 120 r.p.m. Elimination of crosshead reduces height and weight by one-third. Bulletin Form 836.—*Busch-Sulzer Bros.-Diesel Engine Co., St. Louis, Mo.*

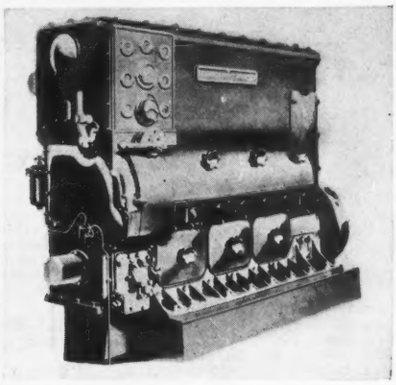
tion. Compact. Herringbone gears exclusively. — *Coppus Engrg. Corp., Worcester, Mass.*

GAS CLEANERS

B-T GAS cleaner Type 2 removes dirt and dust from gas. Is horizontal cylindrical tank containing bed of iron turnings continuously washed with oil from an overhead trough. Oil is lifted

higher rotative and piston speeds. Injection timing, pressure and quantity in one lever. Built-in duplex rotary scavenging blower with uniflow scavenging. Lube-oil, fuel-oil service and transfer, and circulating-water pumps built in. Five cylinder sizes, 5x6, 6½x8, 8x10, 10x12, and 12x15 in., with 6, 7 or 8 cyl., or 5 cyl. in smallest bore. 50 to 300 hp. per cyl.—*Fairbanks-Morse & Co., 900 S. Wabash Ave., Chicago, Ill.*





SILENCER AND AIR CLEANER

INTAKE-AIR silencer and cleaner combined muffles intake noises and filters grit and dust from air. Types to fit all internal-combustion engines. — *Burgess Battery Co., Madison, Wis.*

EMERGENCY POWER PLANT

50-KW. portable power plant mounted on pneumatic-tired trucks. 230 volts d.c. pr 230, three-phase, 60-cycle a.c. Either current or both available up to capacity of driving engine. D.c. unit acts as exciter for a.c. unit. —*Harnischfeger Corp., Milwaukee, Wis.*

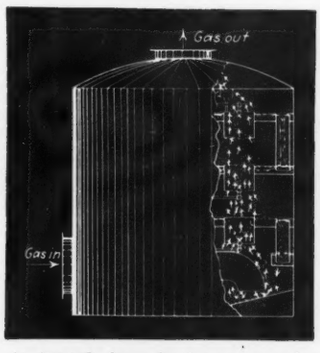
ENGINE GOVERNOR

FOR diesel, gas and steam engines. Powerful, senstive and stable, giving uniformity of action throughout motion of control lever. Two sizes, each with two designs, one for generator service, mills, etc., other for compressor, pipeline and dredge service, etc. Generator unit has speed regulator for plus or minus 5 per cent speed change from normal for synchronizing. Compressor unit has speed regulator for 100 per cent speed change. Control lever can be mounted on either side and at any position in full circle.

Fluctuation (difference in revolutions from top to bottom of stroke, based on revolutions at midstroke) less than 2 per cent. If engine requires higher fluctuation, different overhead springs can be applied. Smaller size unit has work capacity of 10.5 in.-lb. (will handle 4 Bosch PF1C fuel pumps and connecting levers easily), larger 26.4 in.-lb. (will handle 6 pumps and levers with plenty of surplus power). Governors capable of controlling within ¼ cycle for normal load changes. Paralleling two units readily accomplished. For no-load to full-load change, governor will hold engine within 3 to 5 per cent, based on full-load speed.—*Massey Machine Co., 781 Pearl St., Watertown, N. Y.*

2-CYCLE, SLEEVE-VALVE DIESEL

HOWELL 100-hp. (estimated) 2-cycle, 5x6-in. single sleeve-valve diesel runs at 1,800 r.p.m. (maximum 2,000). Air-cooled, but can be converted for chemical or water cooling. Separate Root-type scavenging blower. Full-pressure lubrication. Bosch fuel pump runs at half speed, using two plungers per cylinder alternately. Spray nozzles also Bosch, at 4,000 lb. Built-in Cuno oil strainer. Two bronze connecting rods operate sleeve valve, one on each side, to prevent twist and strain. Weight per hp. 3½ lb.—*Hooper Machine Co., 12-12 44th Ave., Long Island City, N. Y.*



PACKING RING

DESIGNED for severe service. Each ring individually cast of specially dense iron, five rings being standard installtaion. Interchangeable. Hoop spring makes tension more even and constant. — *American Metallic Packing Co., Pittsburgh, Pa.*

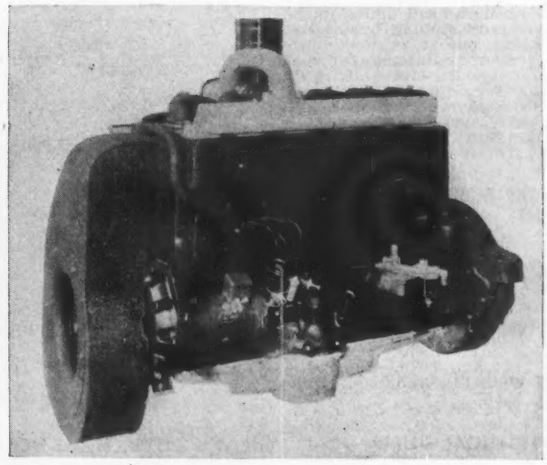
BUILT-IN REDUCERS FOR STEAM TURBINE DRIVE

GIVE low speeds with high-speed steam turbines. Available with either single-reduction or double-reduction units, and for clockwise or counter-clockwise rota-

to trough from bottom reservoir by gas itself. No oil mist or spray. Unit 4 by 14 ft. long will handle 1,800,000 cu.ft. of gas per hr. at 250 lb. per sq.in. with low filter resistance. Sizes to handle any volume. Type 3 unit is vertical, of large capacity, and adapted for cleaning gas with large quantities of solids in suspension, particularly blast furnace gas. — *Burrell-Mase Engrg. Co., Law & Finance Bldg., Pittsburgh, Pa.*

OPPOSED-PISTON DIESEL

LIGHT weight, reduced space, feature this 20 lb. per hp. 2-cycle engine. Fewer parts,

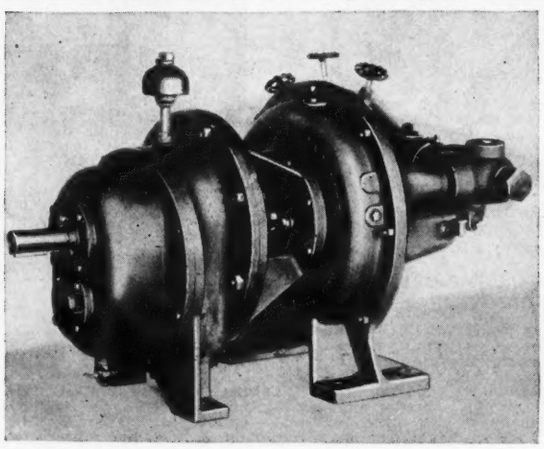


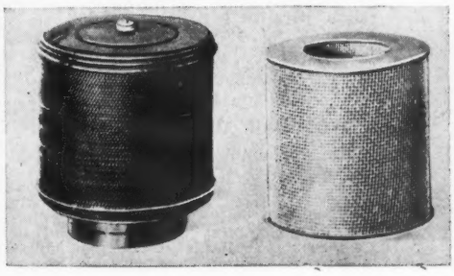
AIR-COOLED ENGINES

MODEL 6A-400 has 4½-in. bore and 5-in. stroke, developing 111 hp. at 2,600 r.p.m. Models 6AH-309, 6AH-377 and 6AH-400, horizontal air-cooled engines develop 85, 104 and 111 hp. respectively. — *Doman-Marks Engine Co., Amesbury, Mass.*

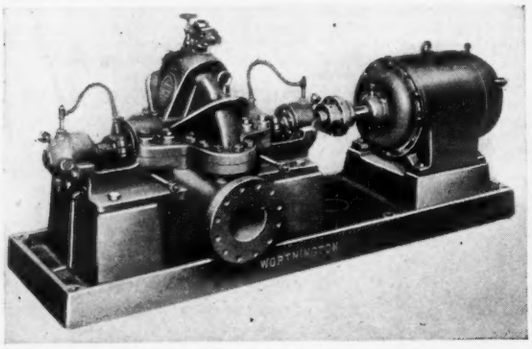
INTAKE GAS CLEANER

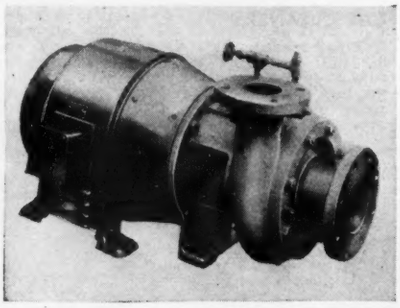
REPLACEABLE, cleanable, viscous-coated cellulose fiber filtering material. High cleaning efficiency and low air restriction. Maximum air velocity permissible 270 ft. per min. Two standard sizes, 5¾ diameter by 4½ in. long, with capacity of 8 cu.ft. per min. and 9x7x12-in. flat unit with capacity of 290 cu.ft. per min. Either unit may be used in multiple for larger capacity. — *Engrg. Dept., Burgess Battery Co., Madison, Wis.*

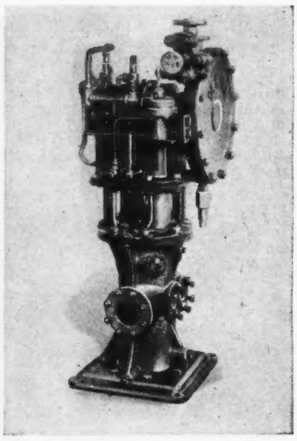




PUMPS FOR POWER PLANT AND INDUSTRIAL USES







CENTRIFUGAL PUMP

EXTRA deep water-jacketed stuffing boxes have pressure breakdown and bleed-off connections, grease sealing glands and large packing space. Steel split smothering glands smother with a stream of water any leakage which might get past stuffing box packing. Bronze bushed to prevent sparking. Large-diameter shafts have low rotative speed. Stages arranged so that even in high-head units, pressure on any stuffing box is not more than one stage above suction pressure. Suitable for cold or hot liquids, either light or heavy, for operation against low or high pressure with low or high suction pressures.—*Worthington Pump & Machinery Corp., Harrison, N. J.*

LARGER-SIZE PUMPING UNIT

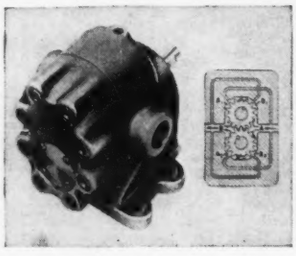
"MOTORPUMP" with built-in electric motor and pump rotor on same shaft, is now built in 26 sizes ranging from ¼ to 30 hp., and from 5 to 1,000 g.p.m. capacity. Certain sizes are two-stage, others are fitted with self-priming attachment. Catalogs Nos. 7464 and 2070.—*Ingersoll-Rand Co., 11 Broadway, New York, N. Y.*

CENTRIFUGAL PUMP

HEAVY parts. Extra deep water-jacketed stuffing boxes have pressure breakdown and bleed-off connections, grease sealing glands, and large packing space. Steel split smothering glands smother with a stream of water any leakage which might get past stuffing box packing. Are bronze bushed to prevent sparking. Large-diameter shafts have low rotative speed.—*Worthington Pump & Machinery Corp., Harrison, N. J.*

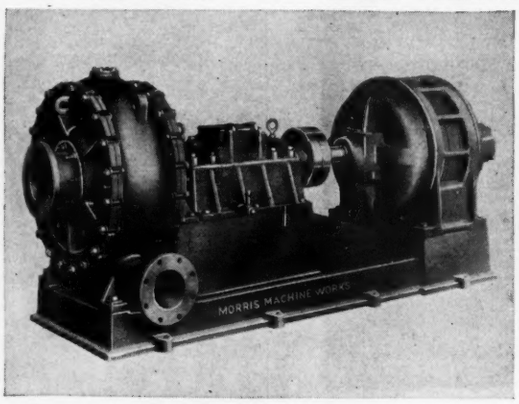
GEAR PUMP AND FLUID MOTOR

VICKERS balanced gear pump and fluid motor cannot bind or "lock." Each gear always in hydraulic balance, thus eliminating thrust loads and consequent wear. When used as motor, can be started under full pressure, and has full torque when stalled. Rotation reversible without internal change. Pressures up to 1,500 lb. per sq.in.—*Vickers, Inc., Detroit, Mich.*



SEMI-METALLIC PACKING

"TRIPPLASTIC" packing includes bearing metal. In coil form of five sizes. Non-scoring, plastic, and conforms to rod shape. Maintains good lubricating surface. Bulletin.—*Wm. B. Merrill & Co., Boston, Mass.*



HEAVY-DUTY, HIGH-HEAD PUMP

TYPE F centrifugal is specially developed for handling extremely abrasive mixtures against high heads. All parts subject to wear semi-steel, manganese steel, or special alloy. Large-diameter casing and impeller permit pump to run at comparatively low speeds. Adapted to ash disposal, coal handling and process work. Sizes from 4-in. to 15-in. discharge for total heads up to 150 ft. and for operation by electric motor or belt.—*Morris Machine Works, Baldwinsville, N. Y.*

CLOSE-COUPLED CENTRIFUGAL PUMP

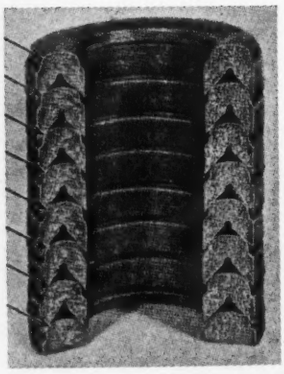
SIDE-SUCTION units called "Standard-Motormount," so designed that any standard ball-bearing motor of open, enclosed, splash-proof or explosion-proof types can be used. No special endbells or shaft. Cradle mounting of pump permits expansion when handling hot liquids. At 1750 r.p.m. capacities 5 to 650 g.p.m.; at 3,500 r.p.m. capacities 25 to 250 g.p.m. Bulletin 4150.—*Deming Co., Salem, Ohio.*

MOTORPUMP UNIT

"BILTON" pump-and-motor unit has capacities from 20 to 500 g.p.m. at 3,600 r.p.m. Heads 50 to 200 ft. Sizes up to 3 in. In single-phase, only 1-, 1½- and 2-hp., 3,600-r.p.m., and 1-hp., 1,800-r.p.m. available. All sizes in 3-phase. Pump case may be arranged to discharge vertically up or horizontally under or over. Standard unit has cast-iron case and bronze-fitted pump. Also, all-bronze units, all KA_n including stainless-steel motor shaft, in special open-runner and explosion-proof motor types.—*Byron-Jackson Co., Berkeley, Calif.*

SELF-SEALING RING PACKING

"PAR" ring packing seals automatically, adjusting to pressure changes. Pressure dissipated on



power stroke through action of shoulder molded in each ring, which forces lips to sides of stuffing box and to rod. Sets of thin rings for hydraulic service (style 860) or high-temperature service (style 870). Bulletin.—*Linear Packing & Rubber Co., 6400 State Road, Philadelphia, Pa.*

STEAM TURBINE-DRIVEN FUEL-OIL PUMP

COMPRISES De Laval-IMO pump set with vertical shaft driven through worm reduction gear by a high-speed steam turbine, which has its casing mounted on gear casings. Steam consumption about half that of ordinary steam-driven pumps. Turbine speed controlled by small hydraulic governor operating throttle valve. Unit designed for continuous operation. Oil for gears provided by a self-contained system. Unit will deliver oil to burners or to lubricant system at any rate up to 500 g.p.m. No valves, shock or pulsation. Comparatively high speed.—*De Laval Steam Turbine Co., Trenton, N. J.*

PORTABLE ROTARY PUMP

HIGH-SPEED rotary displacement pump driven by gasoline engine, mounted on trailer. DeLaval IMO pump, 1,675 r.p.m., 90 g.p.m., against 495 lb. per sq.in. pressure with suction lift equivalent to 14 in. of mercury. Pump weighs 398 lb. and complete set with 60-hp. engine weighs 2,000 lb.—*De Laval Steam Turbine Co., Trenton, N. J.*

TRAP-PUMP UNIT

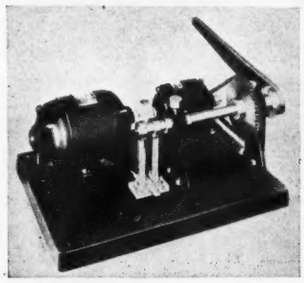
"ELECTRAP" is pressure-equalizing, motor-driven boiler-feed and condensate return unit requiring only ⅛ hp. motor for

1,000 sq.-ft., 125-lb. pressure unit. Combination of two-valve return trap and motor-driven low-head centrifugal pump. When condensate fills trap, vent valve closes and steam valve opens, admitting steam at boiler pressure, and mercury switch trips to start pump. As pressures equalize, pump has only to raise water to boiler and overcome pipe friction. When trap has emptied, steam valve closes, vent opens and motor stops. Four sizes for boilers of 200, 400, 600 and 10,000 sq.ft. and two series, 60-lb. and 25-lb. maximum pressure. — *Johnson Corp., Three Rivers, Mich.*

LEAD PACKING

"PLASTIC BESTOLIFE" is an intimate mixture of long-fiber asbestos, cotton and a finely divided metallic lead with a lubricant. Under ordinary gland pressures. Fine, uniform metallic lead film forms on friction surfaces to reduction friction and decrease leakage, even if shaft is corroded or worn. Metallic lead content of almost 70%. Two grades: No. 285 for water, acids, alkalis and salines; No. 286 for gas, oil and petroleum products.—*Armite Laboratories, 1900 East 65th St., Los Angeles, Calif.*

REGULATORS AND CONTROLLERS



AUTOMATIC COMBUSTION CONTROL

DFC PROPORTIONING control provides continuous, immediate adjustment of fuel and air. Controls fuel input by balancing gas pressure at burner header with steam pressure in boiler; controls proportions of fuel and air by balancing furnace draft with gas pressure in burner manifold. Neither steam pressure nor relation between fuel and air are affected by variations in line gas pressure or stack draft. Steam pressure maintained constant within limits of 2 per cent plus or minus. Model GND operates on boilers under natural or induced draft and fired with atmospheric gas burners. Also models for use with boilers fired with other fuels and forced-draft, gas-fired installations. May be applied to single boiler or to many boilers when in battery and discharging flue gas to common breeching. Three main parts. Two sizes, one with shaft torque of 100, other 500 ft. lb. Bulletin 320.—*Denver Fire Clay Co., Denver, Colo.*

TIME AND TEMPERATURE CONTROLLER

"THERMOCHRON" combines time and temperature functions to anticipate temperature changes without artificial heating of thermostat. Fractional temperature drop causes heat to be turned on 1 or 2 to 20 min. or continuously, depending upon rate of heat loss of building. Bulletin T-26. — *Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.*

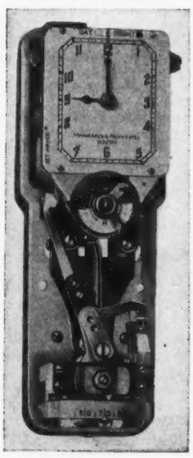
MICRO-REGULATING VALVES

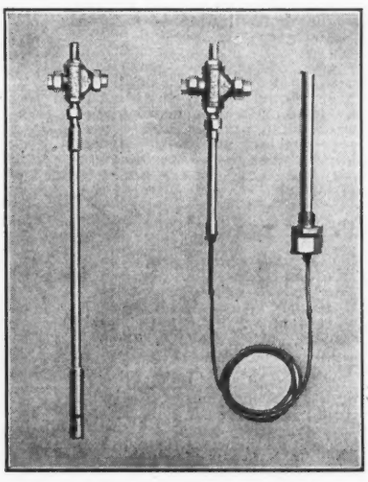
MINUTE regulation of oil to burners, duplication of oil valve settings and operating conditions, minimize clogging, save fuel and time. Also for controlling flow of fluids. Steam connection to prevent solidifying of tarry fuels. Sizes ⅜ to 1-in. pipe, capacities 0-14 to 0-1300 gal. of light oil per hr., half that for heavier oils. Vernier adjustment if desired.—*Hauck Mfg. Co., 126-134 Tenth St., Brooklyn, N. Y.*

TEMPERATURE REGULATORS

TYPE KR-15 (left) Sarco self-operated temperature regulator is for control of brime cooling coils. Temperature - sensitive bulb is rigidly attached to valve, omitting customary flexible connecting tubing. Valve is "packless."

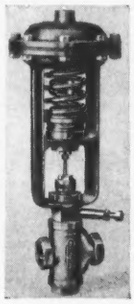
Type TR-20 (right) is new junior model tank regulator in three sizes—¾, ½ and ⅜ in. Has small bulb fitted with union connection and is furnished with short length of connecting tubing.—*Sarco Co., Inc. 183 Madison Ave., New York, N. Y.*





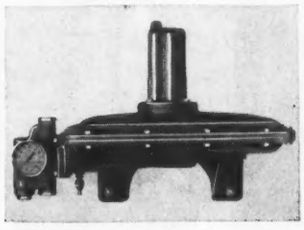
PRESSURE-REDUCING REGULATOR

No. 505 series regulators have non-corrosive stainless steel ball bearings. Flexible multiple springs permit use of larger diaphragms and increase accuracy and sensitivity. Self-aligning spring button prevents spring tilt and slide away from interfering with operation. Grease-sealed stuffing boxes if desired. Bulletin. — *Mason-Neilan Regulator Co., 1190 Adams St., Boston, Mass.*



CONTROLLED VALVE

"STABILFLO" valve reverses unusual positions of diaphragm and spring. Thus more sensitive, smoother valve action. Flexible coupling between motor and valve stem; motor has no guides. Valve-stem lubricator. Flow range 50 to 1 by changes in port design. Bulletin.—*Foxboro Co., Foxboro, Mass.*



DRAFT CONTROLLER

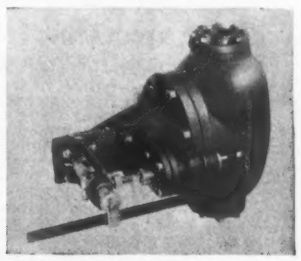
TYPE 90 supersensitive fully compensated unit is primarily used on forced-draft boilers to maintain draft in combustion chamber. Actuated by slight variations in furnace draft; operated by water, air or oil under pressure. Reverses direction on 0.002 in. water. Bulletin 957.—*A. W. Cash Co., Decatur, Ill.*

CONTROLLER

Two types, Type 2119 pressure, Type 1119 temperature, particularly useful where dependable control at definite control point must be had inexpensively. Dial and knob on lower face permit adjustment of temperature or pressure within instrument range. Indicating gage above shows air pressure on diaphragm motor of control valve and also shows whether valve is opening or closing. On temperature controller, 2-in. dial-type thermometer may be installed in place of air gage. Pressure controller may be equipped with high-pressure indicating gage showing pressure being controlled.—*Foxboro Co., Foxboro, Mass.*

AUTOMATIC MANOMETER-REGULATOR

DIRECT and differential pump control, tank level, maintaining gas pressure and flow between narrow limits, also starting and stopping flow in two pipes alternately—*Meriam Co., 1955 West 112th St., Cleveland, Ohio.*

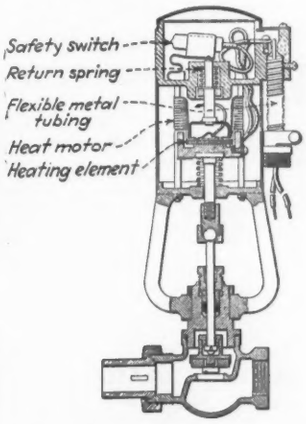


BALL-BEARING REMOTE CONTROL

CONTROLS liquid level. Float chamber has stainless steel balls and races. It will operate valves at any distance up to 300 ft. and permits pressures up to 450 lb. Operating mechanism fully enclosed. Grease-sealed stuffing box optional.—*Swartwout Co., 18511 Euclid Ave., Cleveland, Ohio.*

FURNACE DRAFT REGULATOR

TYPE HF-1 is used primarily to control combustion - chamber draft. Can also be used to control fan speed or ventilating-system pressures or drafts. Fundamental principle that of beam scale, "weighing" draft until desired amount is secured, then maintaining it. No diaphragm. Suitable for boilers up to 2,000 sq.ft. — *Carrick Engineering Co., P. O. Box 299, Michigan City, Ind.*



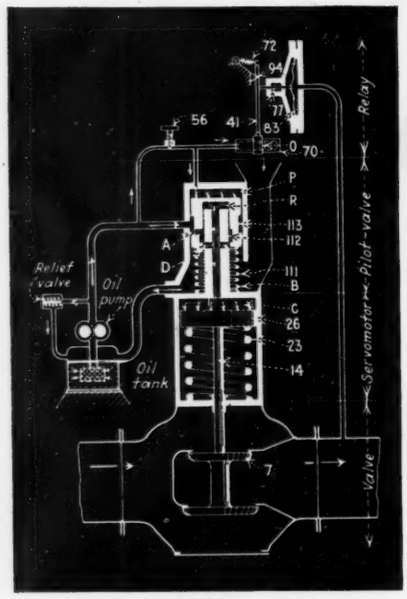
HEAT-MOTOR VALVE

The Engineer (London) describes these heat-motor valves, suitable where snap - acting valves are not necessary. Time

to open or close 3-5 min., energy consumption (even if valve is permanently closed) 17 watts per hr. In normal working consumption is less. Mica-insulated heating resistance used to heat volatile liquid in bellows. Vapor pressure thus developed expands bellows and closes valve. Current supplied to heating element through thermostatic switches in room or tank in which temperature is to be held constant. Voltages up to 250 a.c. or d.c. Silent, and cause no water hammer.—*Drayton Regulator & Instrument Co., Ltd., West Drayton, Middlesex, England.*

AUTOMATIC REGULATING VALVE

AVA REGULATOR, integral part of Ruths Steam Storage System, is now being offered separately. It functions by indirect method, thus enabling small power impulse to control large steam valve. Oil actuated; all moving parts enclosed, special hydraulic return motion to eliminate hunting. Adjustable during operation. Also has hand-operating device and adjustable valve-speed control. One valve, with several impulses, can be controlled from different pressure lines. Servomotor consists of piston 26 and spring 23. Oil pressure at *C* on top of piston balances force of spring. Pilot valve consists of spring 111 and piston 113, with oil pressure *P* balancing spring force.—*Foster Wheeler Corp., 165 Broadway, New York, N. Y.*



LIGHT SOURCE FOR PHOTOTUBE CONTROLLERS

PARTICULARLY useful where light beam is transmitted over a considerable distance or where it must penetrate steam, dust or similar semi-translucent substances. An intensity of 24 ft. candles is obtained at 25 ft.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

MASTER REGULATOR

"THERMO" controls steam temperature after it has passed through a reducing and desuperheating station. Consists of bimetal thermostat. Operating element in steam line on outlet side of desuperheater, power developed being transmitted to 3-way valve. Valve admits pressure to or relieves pressure from main diaphragm-operated valve controlling water supply to desuperheater. Controls temperatures as high as 1,000 deg. F., safety elements for protection in case of water failure.—*Swartwout Co., 18511 Euclid Ave., Cleveland, O.*

MERCURY THERMAL REGULATOR

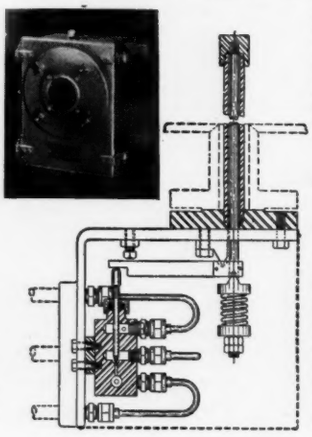
THIS sealed-type mercury-thermal regulator may be easily and accurately set at operating temperature without trial and error. Sensitivity is plus or minus 0.01 deg. C. or better. Setting unaffected by 20-deg. overshoot in temperature. For use with any relay that does not use more than 10 milliamp. operative current.—*American Instrument Co., Inc., 774-776 Girard St., N. W., Washington, D. C.*

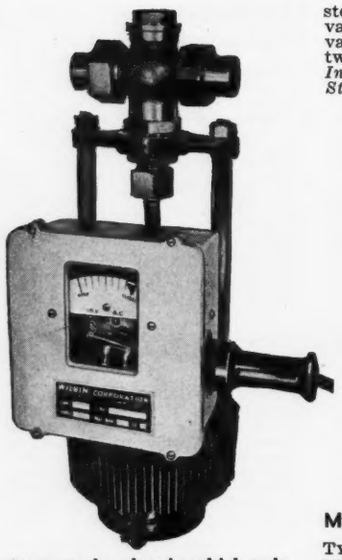
DIAPHRAGM MOTOR VALVE

"SYNCHRO" primarily for air-operated control systems. Responds immediately to pressure changes, and stem position for given pressure is same whether stem is rising or falling. No hysteresis or friction loss in top movement. Union and valve bodies either V-port or single-seated.—*Bristol Co., Waterbury, Conn.*

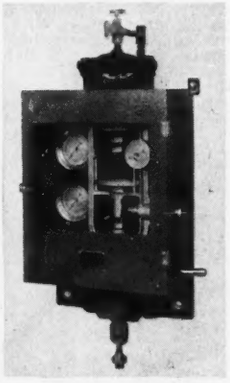
ELECTRIC TEMPERATURE CONTROL

WILBIN heat motor valve Type C, for throttling control of temperatures from minus 40 deg. F. to 650 deg. F. Consists of





pressure chamber in which volatile fluid is vaporized by electric strip heater. Pressure compresses flexible bellows in chamber. Valve plunger attached to bellows then moves upward. Limit switches, actuated by valve stem itself, control and reverse valve stroke. Possible to arrest valve travel at any point between open and closed.—*Wilbin Instrument Corp., 40 East 34th St., New York, N. Y.*



MASTER CONTROL

TYPE CPQM provides accurate pressure control where frequent adjustments are necessary. Consists of pressure regulator with small indicating dial and two main pressure gages.—*Swartwout Co., 18511 Euclid Ave., Cleveland, Ohio.*

STEAM TRAPS

THERMOSTATIC STEAM TRAP

TAG THERMOSTATIC steam trap in three sizes, ½, ¾ and 1 in. Adjusting screw at top may be set to discharge condensate at temperature corresponding to as much as 20 lb. less than operating steam pressure, whether it is 50, 75 or 125 lb. Renewable and reversible Monel seat, renewable stainless steel ball valve, renewable valve guide. Bulletin 1084.—*C. J. Tagliabue Mfg. Co., Park & Nostrand Aves., Brooklyn, N. Y.*

STEAM TRAP

FLOAT seamless copper, tested to 500 in. Powerful leverage maintained high enough to submerge mechanism, thus avoiding wire-drawing and valve hammer. Unaffected by pulsating pressures. Valve seat phosphor bronze, renewable. Valve stem. Monel, reversible and renewable. —*Nason Mfg. Co., 71 Fulton St., New York, N. Y.*

TRAP

MULTI-GRAVITY trap automatically handles water, oil or any two or more liquids of varying specific gravities. Works equally well at all pressures without change of orifice. Ready to operate as soon as connected. Valve Monel metal, float stainless steel. Electric heating unit added when unit is used out-of-doors and subjected to freezing temperatures.—*J. E. Swendeman, Inc., 171 Camden St., Boston, Mass.*

BUCKET TRAP

"TITAN" trap in 4 sizes, pressures to 300 lb. per sq.in. "Tiny" in 2 sizes, pressures to 150 lb. per sq.in. High capacity and compactness obtained with lever in top of trap so bearings will be in clean water protected from wear by scale and grit. Sudden complete opening and quick tight closing. Adaptable to change in pressure by changing seat. Mechanism removable without taking trap from line.—*Nason Mfg. Co., 71 Fulton St., New York, N. Y.*

STEAM TRAP

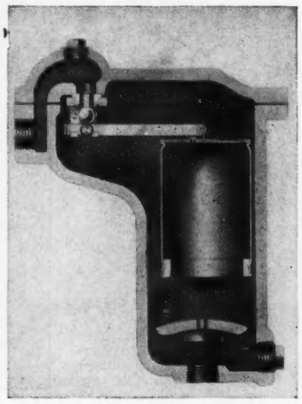
"DETROIT" steam traps, including return, vacuum, combination, and separating traps and "Detroit" receiver now handled by company below. This trap is an arrangement of valves, actuated by tilting tank through an arrangement of levers. Able to return water to boiler at temperatures to 335 deg. F. Counter records number of cycles.—*Nason Mfg. Co., 71 Fulton St., New York, N. Y.*

COMBINATION TRAP

TYPE FTO-H, combination float-thermostatic steam trap now for pressures to 180 lb. per sq.in. Supported directly on piping. All working parts on cover. Main discharge valve and seat stainless steel.—*Sarco Co., 183 Madison Ave., New York, N. Y.*

INVERTED-BUCKET STEAM TRAP

WATER passes freely through without raising bucket. Steam causes bucket to become buoyant, rising and closing valve. Air vented through hole in top of bucket. Free-turning ball valve. Curved baffle over inlet. Valve and seat, lever and all pins are stainless steel.—*D. G. C. Trap & Valve Co., 9 East 46th St., New York, N. Y.*

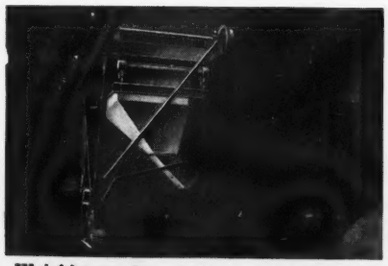


Use LINK-BELT COST-REDUCING CONVEYORS for Coal and Ashes Handling

The Link-Belt Automatic Under-Feed Screw Type Stoker. A rugged, dependable unit, simply designed for efficient, fool-proof service.

The Peck Overlapping Pivoted Bucket Carrier. The one machine handles both coal and ashes.

An efficient, economical coal handling installation of moderate size, for storage, and handling to stoker hoppers.



Weighing and recording coal delivered, is a check on plant efficiency—use Link-Belt Traveling Weigh Larry.

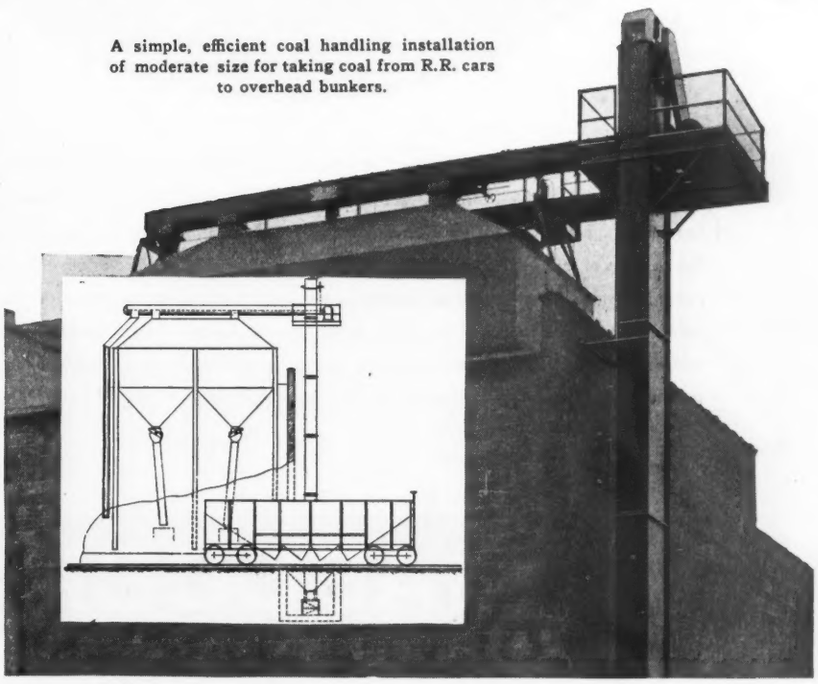
Steam and power costs can be reduced through greater efficiency in handling coal from cars to boiler and in ashes disposal. Are your methods in line with today's best practice? Consult an experienced Link-Belt engineer. Link-Belt products include: elevators and conveyors of the bucket, belt, flight, apron, and gravity-discharge-bucket types; underfeed screw type stokers; skip hoists; weigh larries; coal crushers; water intake screens; locomotive and crawler type cranes; portable conveyors; feeders; bins; gates; etc. Send for catalogs.

LINK-BELT COMPANY

Chicago Philadelphia Indianapolis San Francisco Toronto
Offices in all Principal Cities

5033-B

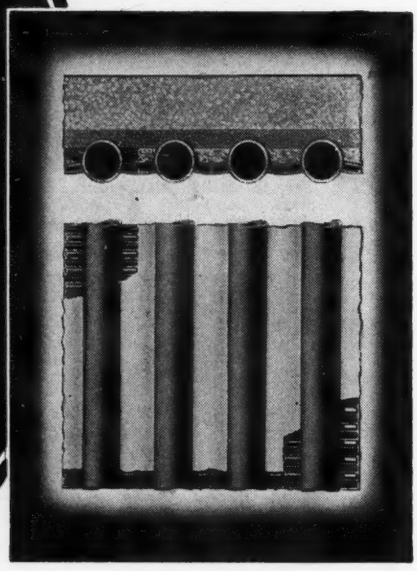
A simple, efficient coal handling installation of moderate size for taking coal from R.R. cars to overhead bunkers.



a complete boiler unit

for lower steam

water-cooled furnace



The B&W Integral-Furnace Boiler . . . a complete, well-balanced unit, including boiler, superheater, water-cooled furnace, fuel-pulverizing, burning, and control equipment . . . has advantageous features heretofore available only in equipment for the largest plants. The newness of this unit lies merely in the manner of assembly of the various thoroughly proved constructions utilized. High operating efficiency is obtained regardless of the fuel used, because of the design of the water-cooled furnace, the cross-flow of gases, the use of smaller tubes in the second and third passes, and to the effective slag screen, which effectively prevents the accumulation of slag on the heating surfaces when pulverized coal is the fuel.

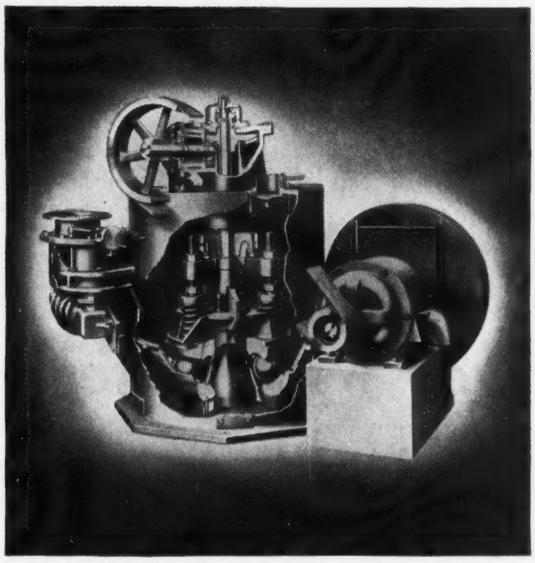
Section of the Stud-Tube Water-Cooled Furnace Construction used with the Integral-Furnace Boiler. This construction assures low maintenance, minimum outage for repairs and replacements, and high availability. It fills all the requirements for economical and trouble-free operation with pulverized coal, through the maintenance of temperatures high enough to assure quick ignition and rapid combustion and low enough to prevent excessive slagging of the boiler tubes, and yet is equally suitable for oil or gas fuel.

THE BABCOCK & WILCOX

costs in industrial service..

coal pulverizer with feeder and blower

the INTEGRAL FURNACE BOILER



The B&W Type B Pulverizer with integral feeder and blower . . . an important component of the Integral-Furnace Boiler with pulverized-coal firing. This pulverizer employs the ball-bearing principle of grinding, the most efficient method yet developed, and with which operation at relatively low speed, consistent performance in capacity and fineness of the coal delivered, and low power consumption are assured. Maintenance is unusually low . . . the simple design includes but few wearing parts, and these are of wear-resisting materials that extensive experience has proved best for this service.

The development of the Babcock & Wilcox Integral-Furnace Boiler has been timely, for it offers, at a critical time in plant operation, the best unit yet developed for generating steam in small and moderate quantities, and at an over-all installed cost that is surprisingly low.

The engineering skill and experience of The Babcock & Wilcox Company were focussed on this design to produce a boiler unit that would definitely decrease the cost of generating steam and thereby increase the margin of profit of the average industrial plant.

The unit has already proved that it accomplishes this purpose. Of the 12 units sold, several have been in service sufficiently long to effect impressive reductions in the cost of power and process steam. A cotton mill, for example, (cited only because of complete engineering tests) now produces steam at an overall fuel rate of 1.2 pounds of coal, or 17,200 B.t.u., per kilowatt hour. Other comparable reductions are being made in other installations.

Investigate the possibility of making savings in your plant with the Babcock & Wilcox Integral-Furnace Boiler . . . ideal for the replacement of obsolescent and inefficient equipment, because of the simplification of operation and assured low cost of steam. Address The Babcock & Wilcox Company, 85 Liberty Street, New York.

G-57-T

COMPANY

WRITE FOR THIS FULLY ILLUSTRATED 20-PAGE BULLETIN.

LAGONDA CLEANERS for all tubes

New processes, new conditions, new problems of tube scaling—but always a LAGONDA cleaner to meet them. Scaled tubes in boilers, superheaters, side-walls, evaporators, oil stills,—all sorts of tubular equipment—yield to LAGONDA methods and LAGONDA long experience.

Put the right LAGONDA CLEANER on the job—and keep your tubes clean. The Lagonda Catalog—on request—tells you which type of cleaner you need.

THE LAGONDA MFG. CO.
SPRINGFIELD, OHIO

An Elliott Company Organization
District Offices in Principal Cities X-1518 a

If you want better feed water heating, *plus* corrosion prevention

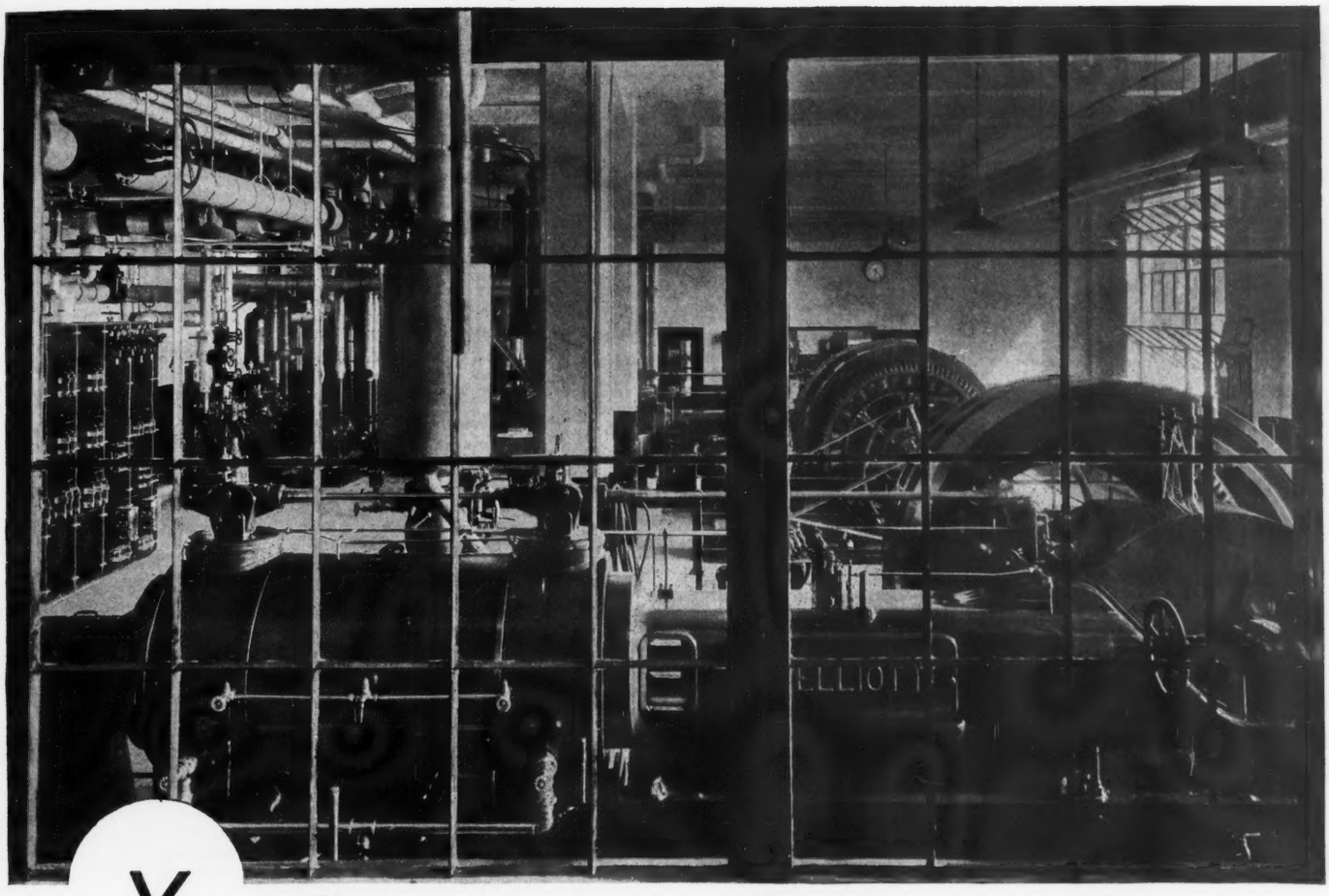
- Investigate Elliott deaerating heaters. For a specific reason, conditions which give deaeration in a heater also insure that the feed water is heated exactly up to the saturated steam temperature. Nobody can ask for better heating performance than that. At the same time, the function of deaeration eliminates all worry about corrosion in boilers, feed lines, steam lines, and steam using equipment.

ELLIOTT DEAERATING HEATERS

As to construction, Elliott deaerating heaters have dozens of superior features which we would be glad to explain to you or which you can find described in descriptive bulletins.

N-926

ELLIOTT



Your plant may call for STEAM ENGINES

●
●
●

ELLIOTT STEAM ENGINES

You can count on Elliott steam engines being modern and up-to-date in every particular. Throughout the engine, refinements bring better operation, more economical and efficient lubrication, and smooth-running, vibrationless performance. A new bulletin B-3 has just been published. A copy will be sent on request.

It takes a careful analysis to determine the best and most economical power generating unit for a particular plant. Rarely do conditions point off-hand to one type of unit.

The steam engine definitely fits into the picture in many cases. And it need not be a unaflow engine either. An Elliott four-valve engine oftentimes meets the conditions better than a poppet valve unaflow engine. (Elliott builds them, too). Elliott also has a Corliss valve unaflow engine which obtains many of the benefits of the unaflow type, but maintains advantages of Corliss valves as opposed to poppet valves.

The Elliott line of engines is complete from the types mentioned down to single-valve and center-crank engines. These are popular, for instance, in school buildings where all of the steam exhausted from the engine, and more too, is required for heating.

Besides a complete line of steam engines, Elliott Company also manufactures all types of steam turbines, from mechanical drive units up to turbine-generators of 7500-kw. capacity. Elliott also builds the generator right along with the engine or turbine as a completely coordinated unit—a potent advantage. Talk over your power generating problem with an Elliott engineer.

B-312

COMPANY PITTSBURGH, PA. *Heat Transfer Dept.* JEANNETTE, PA. *Steam Engine Dept.* RIDGWAY, PA.
Branches and Representatives in Principal Cities

REPRESENTATIVE C-E CONTRACTS—1934

★FORD MOTOR COMPANY,

Detroit, Mich.: One C-E bent tube boiler of special design; rated maximum output, 900,000 lb. of steam per hour; design pressure, 1,400 lb.; total steam temperature, 900 F. Equipped with C-E water walls and screens with suspended walls, two C-E fin type economizers, and two C-E plate type air heaters. Fired by C-E pulverized fuel system.

★CHEVROLET MOTOR CAR COMPANY,

Detroit, Mich. (Baltimore, Md. Plant): Three C-E 4-drum bent tube boilers; rated maximum output, 45,000 lb. of steam per hour each; design pressure, 225 lb. Equipped with C-E water walls. Fired by C-E multiple retort stokers.

★COLGATE-PALMOLIVE-PEET COMPANY,

Jersey City, N. J.: Two C-E 4-drum bent tube boilers; rated maximum output, 85,000 lb. of steam per hour each; design pressure, 440 lb.; total temperature, 600 F. Equipped with C-E side water boxes. Fired by C-E Coxe traveling grate stokers.

★COLGATE-PALMOLIVE-PEET COMPANY,

(Jeffersonville, Ind., Plant): One C-E 4-drum bent tube boiler; rated maximum output, 35,000 lb. of steam per hour; design pressure, 425 lb. Equipped with C-E water walls and water cooled arch, and C-E economizer. Fired by C-E Green forced draft chain grate stoker.

★CONTAINER CORPORATION OF AMERICA,

Chicago, Ill.: One C-E 4-drum bent tube boiler; rated maximum output, 70,000 lb. of steam per hour; design pressure, 448 lb.; total steam temperature, 680 F. Equipped with C-E side water walls and rear arch water screen. Fired by C-E Green forced draft chain grate stoker.

★DETROIT EDISON COMPANY,

(Connors Creek Plant): Two twin set bent tube boilers of special design; rated maximum output, 392,000 lb. of steam per hour; design pressure, 710 lb.; total steam temperature, 850 F. Equipped with C-E water walls, C-E economizers and C-E plate type air heaters. A previous order for two similar units, also received by C-E, was completed this year.

★DUPONT RAYON COMPANY,

Ampthill, Va. (Spruance Plant): One C-E 4-drum bent tube boiler; rated maximum output, 120,000 lb. of steam per hour; design pressure, 450 lb.; total steam temperature, 700 F. Equipped with C-E completely water cooled furnace, C-E tubular air heater and Elesco superheater. Fired by C-E pulverized fuel system.

★FIRESTONE TIRE & RUBBER COMPANY,

Akron, O.: One C-E sectional header boiler; rated maximum output, 350,000 lb. of steam per hour; design pressure, 1,400 lb.; total steam temperature, 769 F. Equipped with C-E completely water cooled furnace, C-E plate type air heater and Elesco superheater. Fired by C-E pulverized fuel system. In addition to the above contract the Firestone Tire & Rubber Company also ordered a C-E Green forced draft chain grate stoker for another boiler of 875 hp. rating.

★CAPITAL ELECTRICITY WORKS,

Nanking, China: Two C-E steam generators; rated maximum output, 133,200 lb. of steam per hour each; design pressure, 525 lb.; total steam temperature, 725 F. Equipped with C-E plate type air heaters, C-E water walls and screens. Elesco superheaters.

★ Rated over $1,000,000.

★HUMMEL-ROSS FIBRE CORPORATION,

Hopewell, W. Va.: Two C-E Murray-Waern System chemical and waste heat recovery units. These units are designed for service in connection with the production of paper pulp. Each unit includes smelter boiler with water cooled walls, waste heat boiler, superheater and air heater—all of special C-E design and construction. Calculated steam production, each unit, when operated at capacity is 500,000 lb. of steam, from and at 212 F., per 24 hours.

★PENNSYLVANIA SALT MANUFACTURING CO.,

Wyandotte, Mich.: One C-E 4-drum bent tube boiler; rated maximum output, 150,000 lb. of steam; design pressure, 448 lb.; total steam temperature, 700 F. Equipped with C-E water walls, screen and water cooled arch, C-E plate type air heater and Elesco superheater. Fired by C-E pulverized fuel system.

U. S. WAR DEPARTMENT,

Wright Field, Dayton, O.: Two C-E 4-drum bent tube boilers; rated maximum output, 62,500 lb. of steam per hour, each; design pressure, 200 lb. Equipped with C-E water walls. Fired by C-E pulverized fuel system.

★U. S. INDUSTRIAL ALCOHOL COMPANY,

New York, N. Y. (Curtis Bay, Md. Plant): Two C-E 4-drum bent tube multiple circulation boilers; rated maximum output, 125,000 lb. of steam per hour; design pressure, 650 lb.; total steam temperature, 685 F. Equipped with C-E water walls and C-E plate type air heaters. Fired by C-E pulverized fuel system.

★WESTINGHOUSE AIR BRAKE COMPANY,

Wilmerding, Pa.: Two C-E 4-drum bent tube boilers; rated maximum output, 68,000 lb. of steam per hour each; design pressure, 575 lb. Equipped with C-E water walls and Elesco superheater.

CITY OF HASTINGS,

Hastings, Neb: One C-E 4-drum bent tube boiler; rated maximum output, 55,000 lb. of steam per hour; design pressure, 440 lb. Equipped with C-E fin tube econmizer, C-E tubular counterflow air heater, and Elesco superheater. Fired by C-E pulverized fuel system.

★DENVER TRAMWAY CORPORATION,

Denver, Colo.: Five C-E 4-drum bent tube boilers; rated maximum output, 50,000 lb. of steam per hour each; design pressure, 233 lb.; total steam temperature, 497 F.

DUVAL TEXAS SULPHUR COMPANY,

Boling, Texas: Four C-E low head bent tube boilers; rated maximum output, 37,500 lb. of steam each; design pressure, 115 lb.

STATE HOSPITAL FOR NERVOUS DISEASES,

Benton, Ark.: Three C-E 275 hp. low head bent tube boilers.

UNIVERSITY OF MISSISSIPPI,

Oxford, Miss.: Two C-E 315 hp. low head bent tube boilers.

NEW HAMPSHIRE STATE HOSPITAL,

Concord, N. H.: Two C-E 316 hp. box header boilers.

OKLAHOMA AGRICULTURAL & MECHANICAL COLLEGE

Stillwater, Okla.: Two C-E 294 hp. low head bent tube boilers.

★THERMOID RUBBER COMPANY,

Trenton, N. J.: Two C-E 295 hp. 4-drum bent tube boilers and two C-E Coxe traveling grate stokers for firing same.

CREIGHTON MEMORIAL ST. JOSEPH'S HOSPITAL,

Omaha, Neb.: Two C-E 294 hp. low head bent tube boilers and two C-E Green forced draft chain grate stokers for firing same.

WESTERN STATE COLLEGE,

Gunnison, Colo.: C-E 181 hp. low head bent tube boiler and C-E Type E stoker for firing same.

CAMPERDOWN COMPANY, INC.,

Greenfield, S. C.: C-E 400 hp. low head bent tube boiler and C-E Type E stoker for firing same.

SWIFT MANUFACTURING COMPANY,

Columbus, O.: C-E 486 hp. box header boiler and C-E Type E stoker for firing same.

★UNION WAREHOUSE CORPORATION,

Union City, N. J.: C-E 400 hp. low head bent tube boiler and C-E Type E stoker for firing same.

U. S. ARMY DREDGE,

"Blackwater": Two C-E 193 hp. marine boilers.

★PUBLIC SERVICE OF COLORADO,

Denver, Colo. (La Grange Station) C-E 4-drum bent tube boiler; rated maximum output, 75,000 lb. of steam per hour; design pressure, 448 lb.

DAH YIH CHENG COTTON MILL,

Shanghai, China: C-E 267 hp. 4-drum bent tube boiler.

★RATH PACKING COMPANY,

Waterloo, Iowa: C-E 4-drum bent tube boiler; rated maximum output, 40,000 lb. of steam per hour; design pressure, 450 lb.

★ARMSTRONG PAINT & VARNISH COMPANY,

Chicago, Ill.: C-E 253 hp. low head bent tube boiler.

SHELBY COUNTY PENAL FARM,

Mullens Station, Tenn.: C-E 327 hp. low head bent tube boiler.

CITY OF MIAMI,

Miami, Fla.: C-E 358 hp. waste heat boiler.

★CHAMPION FIBRE COMPANY,

Canton, N. C.: Four C-E traveling grate stokers for firing black liquor chemical recovery units, and C-E smelter top boiler for same.

★SWIFT & COMPANY,

Chicago, Ill. (Harrison, N. J., Plant): Four C-E Type E stokers for 520 hp. boilers.

★MICHIGAN SUGAR COMPANY,

Saginaw, Mich.: C-E Type E stoker for pulp dryer. A repeat order for two additional C-E Type E stokers was also received this year by C-E from this company for a similar application in their Sebewaing, Mich., plant.

★NATIONAL ANILINE & CHEMICAL COMPANY,

Inc., New York, N. Y., (Buffalo, N. Y., Plant): Two C-E Coxe traveling grate stokers for 509 hp. boilers.

★AMERICAN CAN COMPANY,

Chicago, Ill. (Constantine, Mich., Plant): Two C-E Green forced draft chain grate stokers for 400 hp. boilers.

LEADERS OF INDUSTRY
CONTINUE TO PURCHASE C-E EQUIPMENT

★**CONTINENTAL REFINING COMPANY,**
Oil City, Pa.: Two C-E Type E stokers for 300 hp. boilers.

★**EQUITABLE BUILDING CORPORATION,**
New York, N. Y.: Two C-E Coxe traveling grate stokers for C-E 440 hp. boilers

★**MEAD PAPERBOARD CORPORATION,**
Nashville, Tenn.: Two C-E Type E stokers for 304 hp. boilers.

★**A. C. SPARK PLUG COMPANY,**
Flint, Mich.: C-E Type E stoker for 500 hp. boiler.

★**ALUMINUM COMPANY OF AMERICA,**
Cleveland, O. (Detroit, Mich., Plant): C-E Type E stoker for 300 hp. boiler.

★**GULF REFINING COMPANY,**
Pittsburgh, Pa. (West Port Arthur, Texas): Three sets of C-E water walls for three C-E 1,544 hp. bent tube boilers.

★**BOSTON ELEVATED RAILWAY,**
Boston, Mass.: Two sets of C-E water screens for 1,820 hp. boilers.

★**KOPPERS GAS & COKE COMPANY,**
Seaboard, N. J.: C-E Coxe traveling grate stoker for 615 hp. boiler.

★**PENNZOIL COMPANY,**
Oil City, Pa.: C-E Type E stoker for 410 hp. boiler.

STANDARD BREWING COMPANY,
Rochester, N, Y.: C-E Type E stoker for 308 hp. boiler.

★**WEIRTON STEEL COMPANY,**
Weirton, W. Va.: C-E Coxe traveling grate stoker for 603 hp. boiler.

YOUNG MEN'S CHRISTIAN ASSOCIATION,
Cleveland, O.: C-E Type E stoker for 230 hp. boiler.

★**RAILWAY STEEL SPRING COMPANY,**
Latrobe, Pa.: C-E Type E stoker for 409 hp. boiler.

★**DURHAM HOSIERY MILLS,**
Durham, N. C.: C-E Type E stoker for 180 hp. boiler.

★**FISHER BODY CORPORATION,**
Detroit, Mich. (Flint, Mich., Plant): C-E fusion welded 54-inch boiler drum. A repeat order for a similar drum was also received by C-E this year from this company for their Memphis, Tenn., plant.

★**GENERAL CIGAR COMPANY,**
West Hartford, Conn.: C-E Type S stoker unit for 150 hp. boiler.

★**CANADIAN INTERNATIONAL PAPER COMPANY,**
Gatineau, Quebec: C-E plate type air heater.

Glance through the accompanying list of 1934 buyers of C-E equipment and note the number of names that qualify as leaders in the various industries represented. Note also the range of work from small boilers and stokers to the Ford Motor Company unit designed to produce up to 900,000 lb. of steam per hr. at 1400 lb. pressure and 900 F. total temperature. . . . When you buy C-E equipment you are purchasing the products of an organization which has the confidence of buyers whose facilities for investigation of relative equipment values are the best obtainable. Furthermore you are dealing with an organization whose experience in the complex problems of combustion, steam generation and heat recovery is as comprehensive and diversified as its line of products—in short a company that can assure you an installation correctly engineered for your *particular* requirements whether you are buying a stoker for a boiler of less than 100 hp. or a steam generating unit larger than any thus far built. . . . We submit this partial list of our 1934 work as evidence of our ability to serve you in connection with any plans you may have for modernizing, replacing or adding to your present boiler plant facilities.

COMBUSTION ENGINEERING COMPANY, INC.
200 MADISON AVENUE, NEW YORK

Canadian Associates, Combustion Engineering Corporation, Ltd., Montreal

MANUFACTURING PLANTS:

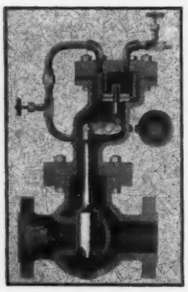
The Hedges-Walsh-Weidner Company, Chattanooga, Tenn.; Coshocton Iron Company, Monongahela, Pa.; Raymond Brothers Impact Pulverizer Company, Chicago, Ill.; Heine Boiler Company, St. Louis, Mo.

C-E

A-203

ENGINEERING

WHAT BETTER EVIDENCE

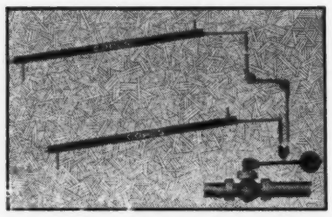


COPES Type SS-2 Valve maintains uniform pressure drop across feed control valve at all times. Recommended where excess pressure varies plus or minus 25% from normal.

In the first 11 months of 1934, the boiler feed systems in 233 power plants . . . with from one to eight boilers each . . . were made thoroughly modern with fully-automatic COPES Control. What better evidence could be offered to support these statements:

1. Correct feed water regulation should be an important part of every boiler modernization program . . . near the top of your 1935 budget for plant improvements.
2. Alert engineers who look beyond the quoted price for value . . . for dependable performance and long service life . . . prefer COPES Regulation to any other type.
3. Some type of COPES Feed Water Regulator . . . level control, level and pressure control or responsive to steam flow . . . offers a means of improving your boiler operation, of cutting your boiler room costs.

May we present information on how COPES Feed Water Regulation will benefit you?



Recommended where boiler loads fluctuate rapidly. COPES Double Control Regulator is responsive to steam flow with compensation for water level changes. More in service than all other makes of steam-flow type regulators combined.

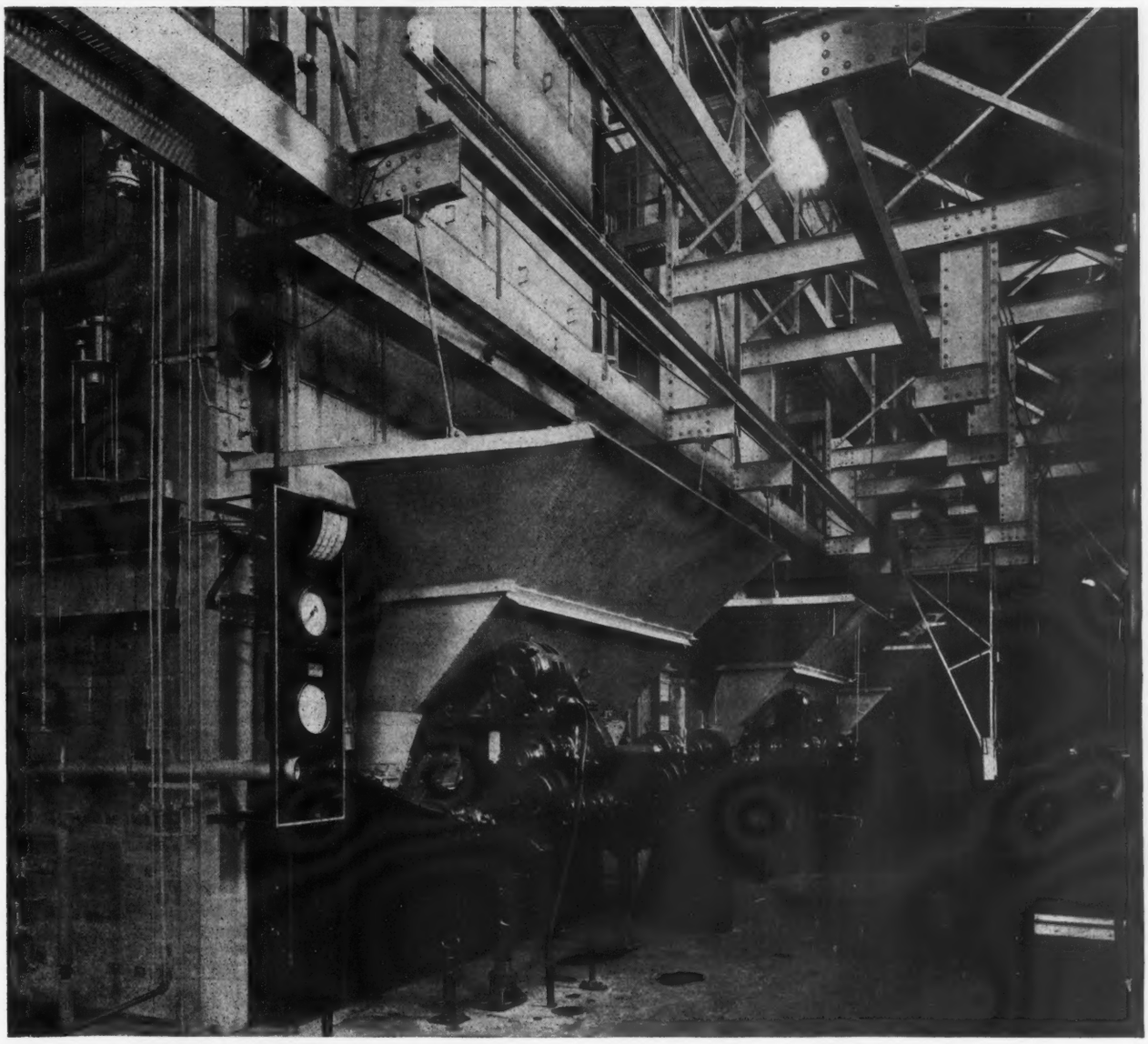
COPES
SYSTEM OF BOILER FEED CONTROL

NRA CODE SCIENTIFIC APPARATUS INDUSTRY 1934

NORTHERN EQUIPMENT CO.

1221 GROVE DRIVE, ERIE, PENNSYLVANIA

BRANCH PLANTS IN CANADA, ENGLAND, FRANCE, GERMANY, AUSTRIA, ITALY REPRESENTATIVES EVERYWHERE



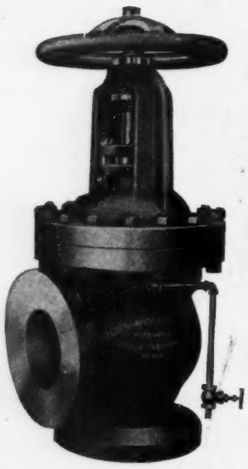
St. Elizabeth's Hospital

Three, new, cross drum, forged steel, sectional header boilers were furnished this year for the power plant of this large Federal institution at Washington, D. C. Each boiler has 7500 square feet of heating surface, is fitted with convection superheater for 115 deg. F., and operates at 225 lb. gauge pressure. Many Government boiler plants are equipped with Foster Wheeler apparatus constructed under most searching inspection and tests of Federal engineers.

Equipment of this high quality is always furnished by Foster Wheeler. It has been supplied for power plants in the Navy Yards, as well as for Naval and auxiliary vessels. Other Government boiler orders are going through the shops at this time.

Working to the highest standards insures fine equipment and maximum return on the investment.

FOSTER WHEELER CORPORATION, 165 Broadway, New York, N. Y.



AUTOMATIC DOUBLE CUSHIONED TRIPLE-ACTING AND NON-RETURN VALVES

For protection of life and property, no finer investment can be made in any plant than the installation of a good non-return valve that will work without sticking. The Golden-Anderson Non-Return Valve is the finest valve of its type. Thousands of them are in service today in every industry—including more than 5000 in steel mill power plants.

Automatically cut out the boiler the instant that a tube rupture or other internal break occurs.

Automatically cut off the steam flow from every boiler the instant that a steam pipe breaks.

Automatically equalize the pressure between all boilers.

Automatically cut in a boiler, making accidents due to inaccurate steam gauge impossible.

Positively prevent backflow of steam into a cold boiler.

Can be closed by hand, like ordinary stop valve, and arranged with "combination feature" to open valve like regular gate and globe valve.

Can be tested in service from boiler room floor.

Double Corliss Dash Pot that cushions in opening and closing. As they are sealed and out of current steam flow, dirt and grit cannot bind or stick valves.

Cannot pound, spin, stick or chatter.

By disconnecting pilot valve, the triple-acting style can be changed into plain non-return.

GOLDEN-ANDERSON VALVES

GOLDEN-ANDERSON
Automatic "Cushioned" Controlling Altitude Valves Guaranteed

Keep the water level constant in reservoirs, standpipes, tanks, etc., under all conditions.

Very simple in design. Contain no floats or fixtures inside or outside of tanks.

A perfect cushion by water and air absolutely prevents water hammer, surges and broken mains. No metal-to-metal seats.

Can be closed in three ways:

1. Automatically, by water.
2. By electricity, if desired.
3. By hand.

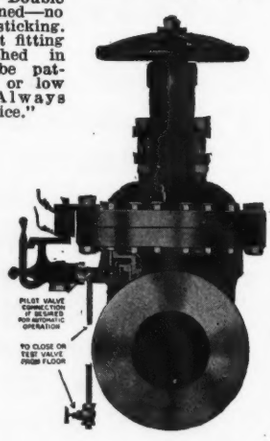
May also be arranged to automatically close when a break occurs in the mains. When necessary, they may be so connected as to "work both ways" on a single line of pipe.

The Golden-Anderson line also includes check valves, float valves, pressure reducing valves, etc. New Catalog of complete line sent on request.

NEW CATALOG NOW READY

GOLDEN-ANDERSON
Double "Cushioned", Quick-Closing Emergency Trip Valves

Golden-Anderson combined throttle and automatic engine stop valves have been protecting engines and turbines from "run-aways" for over 25 years. Operate three ways: Automatically, by hand, or by electric switch. Prevent flywheel explosions. "Double Corliss" cushioned—no pounding or sticking. Contain no tight fitting parts. Furnished in angle and globe patterns for high or low pressures. "Always Ready for Service."



GOLDEN-ANDERSON VALVE SPECIALTY CO.
1314 FULTON BUILDING ~ PITTSBURGH PA.

EVERY DOLLAR SAVED *in Steam Cost* ADDS A DOLLAR TO NET PROFITS

A saving of 5% on your fuel bill is equal to the net profit on how much new business?

The day is rapidly approaching when no man will operate a boiler plant unless it is equipped with the means whereby its daily performance may be checked and its operation closely controlled.

In generating stations, the cost per unit of electricity fluctuates as the boiler house efficiency, while the cost of steam in industry has a far-reaching effect upon net profits.

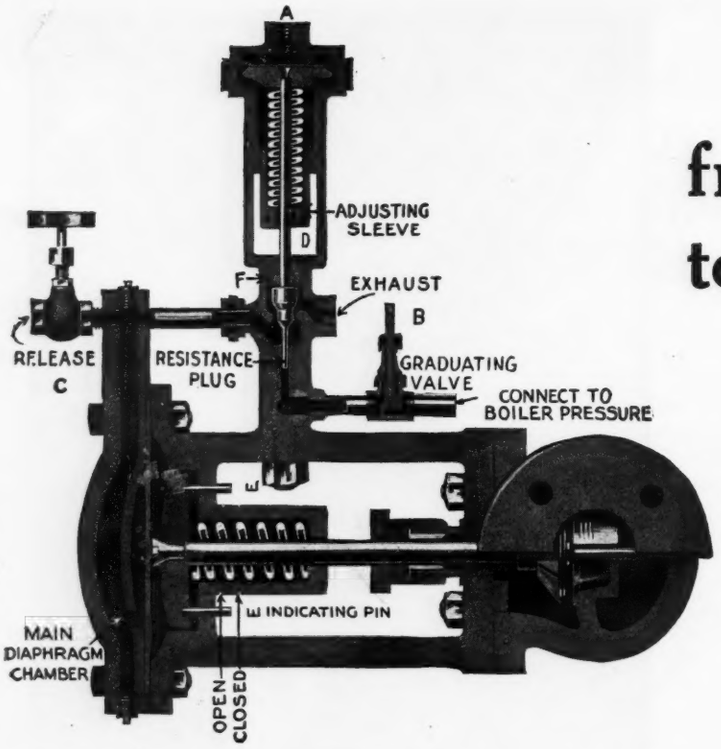
Control cannot be effective unless based upon truth-telling instruments which give reliable guidance to operators at the operating platform —and provide essential records at a convenient point for the engineer in charge of plant operation.

When you decide—as you eventually will—to take full advantage of the assistance modern instruments can render, a statement of your problem to Republic will make available an unmatched engineering service. Our engineers will be glad to study your problem and make recommendations which will be of practical aid in reducing the cost of steam in your plant.

WRITE FOR BULLETIN "REPUBLIC ECONOMY IN INDUSTRY"

REPUBLIC FLOW METERS CO.

2222 DIVERSEY PARKWAY CHICAGO, ILLINOIS



from *all* pressures to *any* pressure in *one* operation

SQUIRES Reducing Valves

A positive Dead End Valve

No matter how difficult the service may be, Squires Reducing Valves deliver the necessary pressure. Simple construction and easy accessibility of working parts insure the Squires Valve's continuous and accurate performance.

Control of this valve is by a pilot valve which is governed by the low pressure side. Delivery pressure is independent of the high pressure side and its maintenance is certain. Operation is automatic when the pilot valve is set.

The durability and sensitivity of Squires Patented Diaphragms, which are used in all Squires Reducing Valves, Pump Governors and Boiler Feed Water Controllers, add to the superiority of Squires operation.

Complete details about the Squires Line may be had on request. Consult our engineers.

Send for Catalog A-1-10

Other Genuine Squires Steam Specialties

Standard Genuine Squires Steam, Air and Blast Traps

New Genuine Squires Steel Trap

Class "E" Pump Governor
Class "H" Pump Governor
Class "B" Excess Pump Governor

Boiler Feed Water Controller

Insist on the Genuine **Squires** **Steam Specialties**

THE C. E. SQUIRES COMPANY — E. 40TH ST. & KELLEY AVE., CLEVELAND

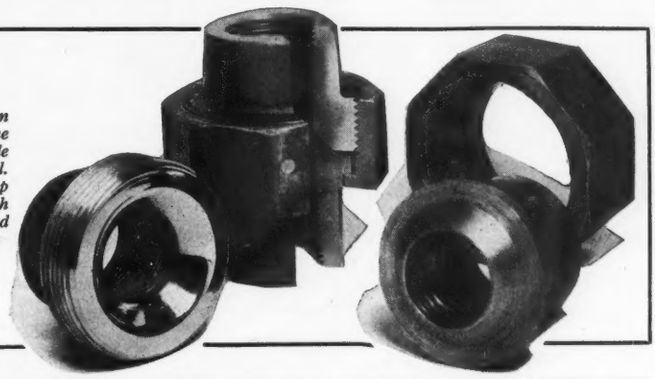
No. 6 of a series of advertisements addressed to engineers.

Inside MONEL METAL Facts

Monel Metal is a registered trade-mark applied to an alloy containing approximately two-thirds Nickel and one-third copper. Monel Metal is mined, smelted, refined, rolled and marketed solely by International Nickel.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL STREET, NEW YORK, N. Y.

NON-"FREEZING" PIPE UNION, MADE OF FORGINGS RESISTS UP TO 1,000° F. OR 3,000 LB. PRESSURE!



High pressure pipe union manufactured by Crane Co., Chicago, Ill. Made entirely of forged metal. The threaded end is drop forged Monel Metal with seating surface ground to receive forged steel tail piece.

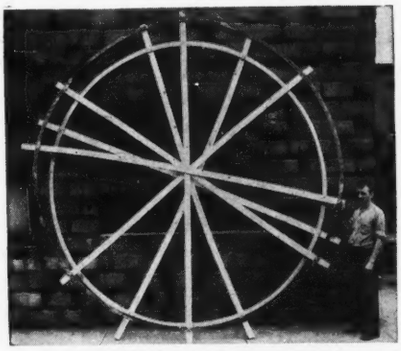
THE Crane Co., Chicago, Illinois, makes a high pressure pipe union with several distinctive features.

All the parts are forgings. The conical male end and the union ring are forged steel, while the female end is forged Monel Metal with a ground seating surface.

The result is a non-corrosive seat that, even when used at highest temperatures or highest pressures, is completely proof against leaks.

This forged Monel Metal seat is standard on the Crane 246-H high-pressure union. It is used for superheated steam or hot oil at 900 lbs. 750° F., for hot oil at 725 lbs. 1,000° F., and for cold water, oil or gas at 3,000 lbs.

The parts are easily separated at disassembling, because Monel is absolutely rust-proof and cannot "freeze" with steel. Likewise the threaded steel union ring cannot "freeze" or rust to the outside threads of the Monel part, which in turn will not "freeze" to the pipe.



Large Monel Metal gaskets 13' and 12' diameter. Made by the Akron Metallic Gasket Co., Akron, Ohio.

UNUSUAL GASKETS MEET SEVERE CONDITIONS OF CHEMICAL PLANT SERVICE

The Akron Metallic Gasket Company, Akron, O. received an order from an important chemical concern, for two large gaskets. One 13 feet and the other 12 feet in diameter.

Chemical plant use obviously involved very severe corrosion conditions. It was therefore essential that these gaskets should give not only a tight seal against the ordinary leaks caused by seepage of fluids, but should also obviate leaks caused by the destructive action of chemicals.

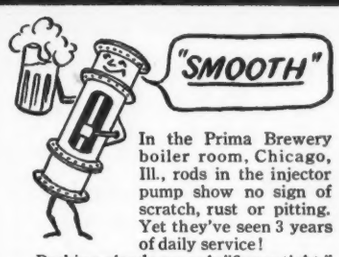
A material possessing stubborn resistance to corrosion was called for.

(Continued at top of next column)

So the gaskets were constructed of two layers of Monel Metal, separated by a layer of asbestos.

Monel was selected because this high Nickel alloy is absolute proof against rust and resists many kinds of corrosion, often at elevated temperatures.

CAN YOU BEAT IT?

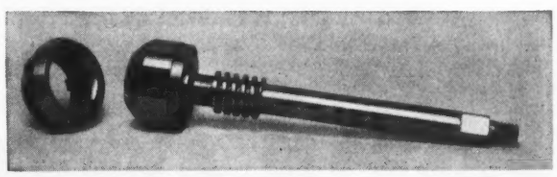


In the Prima Brewery boiler room, Chicago, Ill., rods in the injector pump show no sign of scratch, rust or pitting. Yet they've seen 3 years of daily service!

Packing glands are only "finger tight." For the rods have "polished-in" as smooth as glass, and a perfect oil seal is the natural consequence.

Explanation: they are *Monel Metal pump rods*, therefore completely rust-proof, and able to withstand corrosion of many kinds.

Can you beat it? If you know of a comparable case of Monel Metal pump rod performance, please tell us about it.



Monel Metal seat ring, disc and stem. Machined from cold drawn Monel bar stock for use in high pressure steam valves with drop forged steel bodies as manufactured by Henry Vogt Machine Co., Louisville, Ky.

Monel Valve Parts Foil Rust, also Erosion by High Pressure Steam

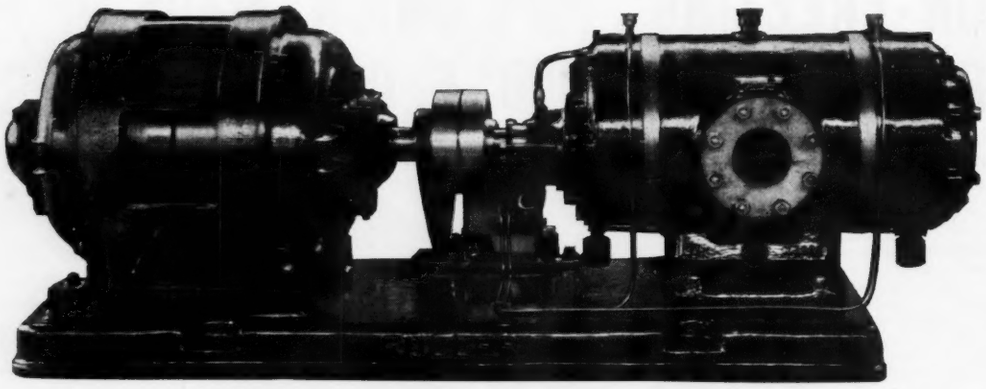
When you get a high pressure valve from Vogt's, you can specify a seat ring, disc and stem that neither steam nor condensate can rust.

For such parts may be Monel Metal, the high Nickel alloy that is absolutely rust-proof.

Monel's toughness resists the erosion and distortion of steam, even at highest pressure and temperatures.

The Henry Vogt Machine Co., of Louisville, Ky., machines Monel Metal valve parts from cold drawn Monel bar stock... and so adds greatly to the life of the equipment.

COMPACT—DEPENDABLE

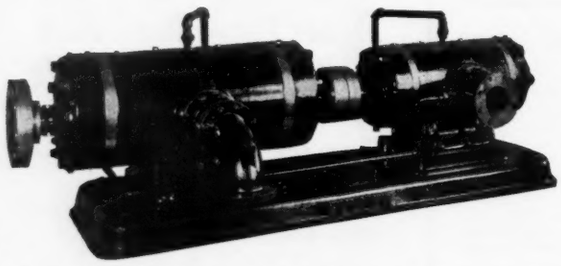


Size C-60, single-stage compressor, providing a capacity of 240 C.F.M. free air, compressing to 50 pounds gauge.

The average compressor operating engineer has often hoped for and even visualized a compressor unit embracing simplicity of design, installation and operating ease. Fuller Rotary Compressors have these characteristics.

Continuous rotary motion eliminates vibration, expensive foundations and pulsations in air lines. These compressors have rotors running in two heavy-duty roller bearings. There is no continual bearing take-up involved. A forced-feed lubricator assures correct lubrication at all times at all necessary points.

Due to their small size in relation to free air delivered, Fuller Compressors are ideal replacements for obsolete compressor house equipment, or if conditions warrant, these compact units should be placed close to the point of air consumption to overcome losses incurred with long transmission lines.



Type C-150-80, two stage, Fuller Rotary Air Compressor. Actual free air delivery 750 C.F.M. at 100 pounds gauge pressure. Two-stage vacuum pumps are of the same general arrangement.

Fuller Rotary Compressors have solved a large number of difficult installation problems, where dependability is essential, and loss of efficiency cannot be tolerated.

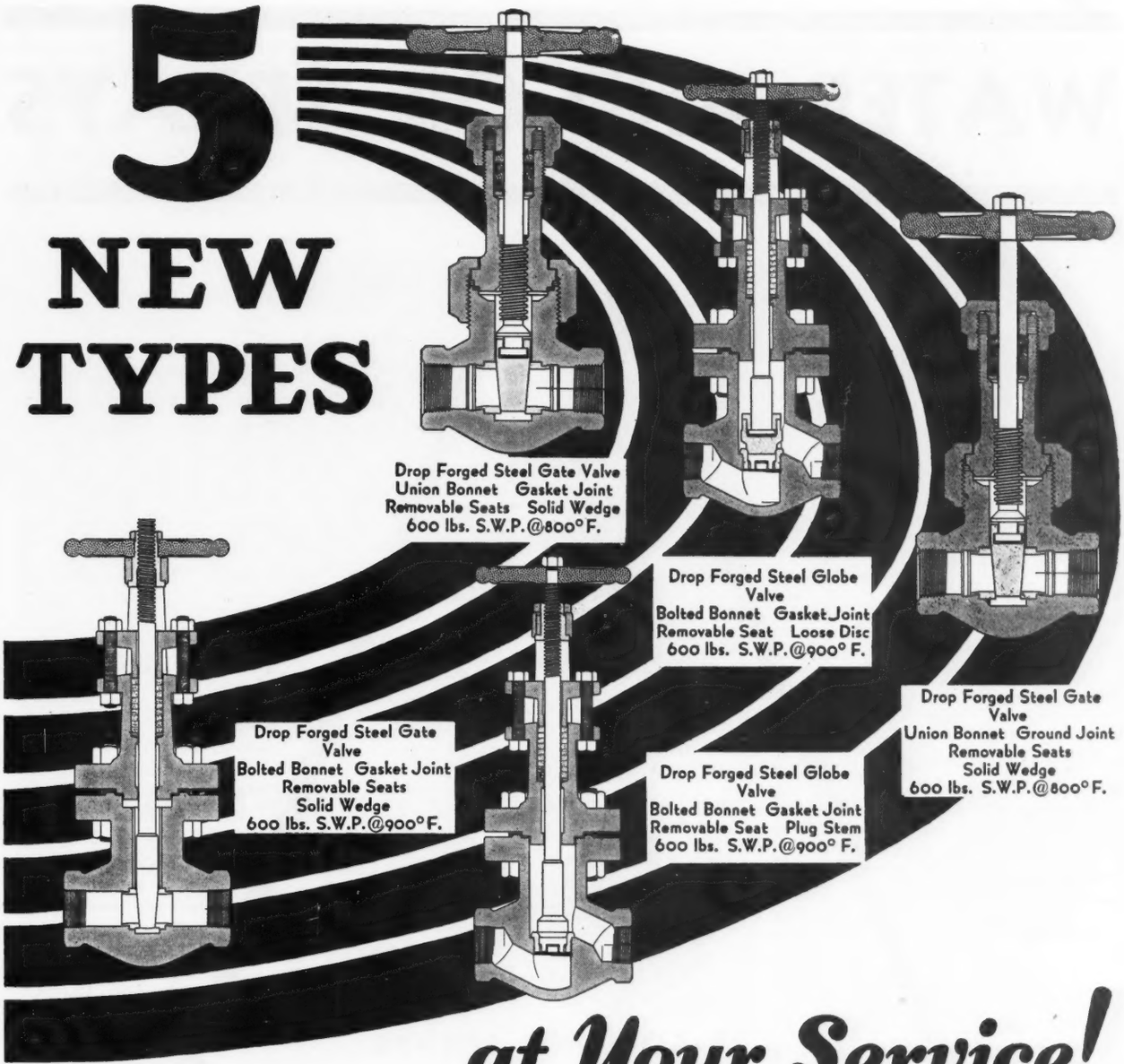
Write for Bulletin C-3A for full details.

CHICAGO: 1118 MARQUETTE BLDG.

Fuller Company

CATASAUQUA, PENNA. U. S. A.

5 NEW TYPES



at Your Service!

Write for Catalog F-7

New York
Chicago
Cleveland
Philadelphia
Dallas
Cincinnati
Kansas City

Put them to work in your plant!
They will give long uninterrupted service with absolute safety under the most trying conditions. Positive control and quick release are characteristic of Vogt valves. Strength and endurance, that drop forging *alone* can give, are developed to the highest degree.

Make real valve economy and satisfactory performance certain by specifying VOGT DROP FORGED.

HENRY VOGT MACHINE COMPANY
LOUISVILLE Incorporated KENTUCKY

Manufacturers of: Drop Forged Steel Valves and Fittings, Oil Refinery Equipment. Water Tube Boilers, Ice Making and Refrigerating Machinery, Heat Exchangers

Vogt *drop forged* STEEL VALVES

WATER AND OIL SPRAYS

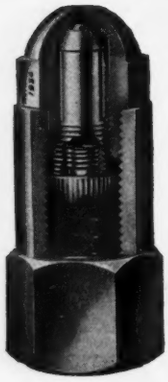


Fig. F-27

ATOMIZING NOZZLES

This nozzle breaks up the liquid into the finest spray possible with direct pressure—no air or steam as the atomizing medium. Stainless steel tip and disc make it highly resistant to corrosion. For oil or water, but if for the latter must be specially tested.

Bulletin No. 16

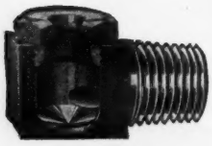


Fig. 629

NON-CLOG NOZZLES

Available in ⅜" male pipe size and in ⅜" and ¼" female (fig. 631.) For industrial air washers size delivering 68 G.P.H. at 20 lbs. is strongly recommended.

Catalog 6-C

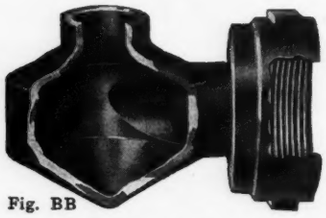


Fig. BB

RE-COOLING SPRAYS

For re-cooling condensing water in spray ponds. Conical swirl chamber tends to balance liquid, giving an even spray. Made in 1", 1½", and 2" pipe sizes.

Catalog 6-C

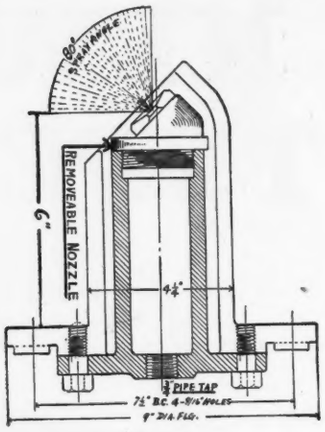


Fig. B-9

ASH QUENCHERS

So constructed they produce a relatively "solid" spray cone of about 80 degree included angle, wetting the entire sprayed area of ashes with equal volume of water. Available as illustrated and also in fig. C-113 which sprays parallel to body instead of at 45 degree angle.

Catalog 6-C

AIR OR STEAM OIL ATOMIZER

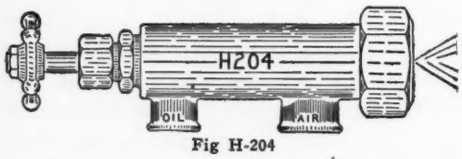


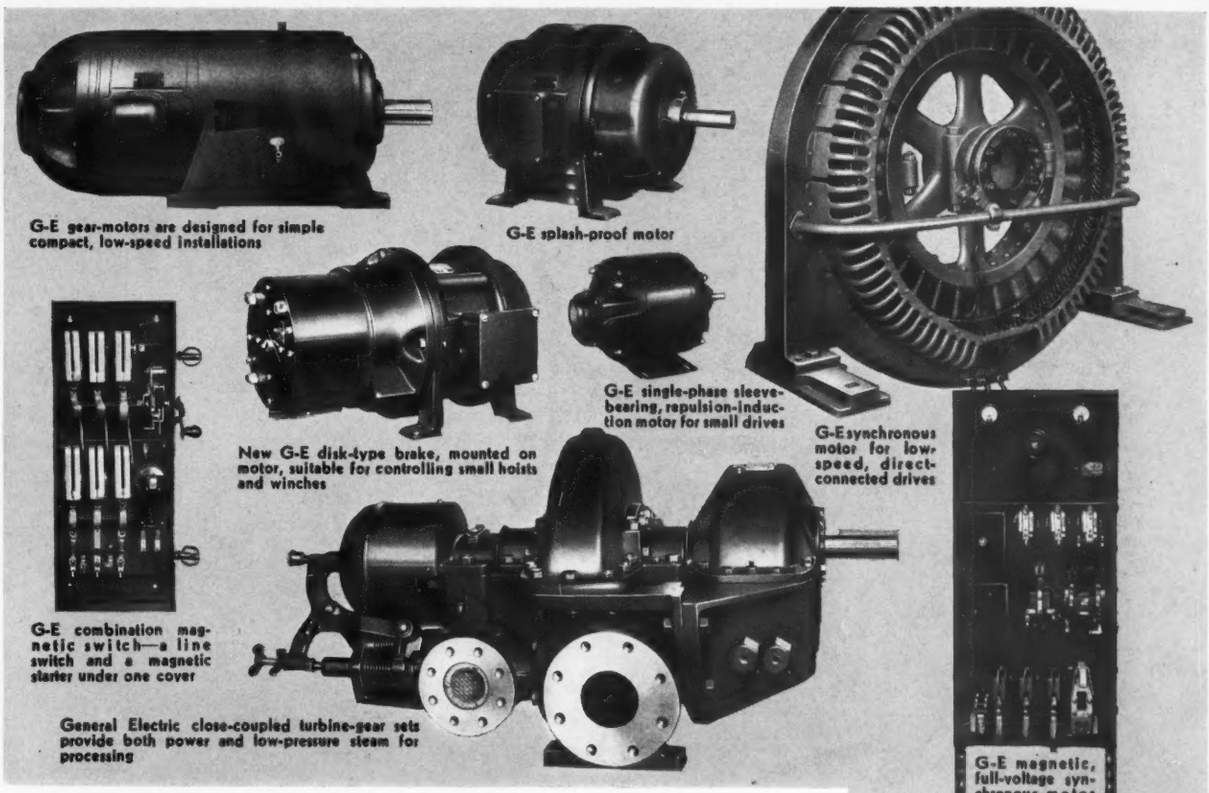
Fig H-204

Will burn real No. 4 oil efficiently without heating, using 3 to 4 lbs. air pressure. Adjustable for different capacities. Air and oil are intimately mixed before discharge into furnace by specially designed nozzle head.

Write for complete information

MONARCH MFG. WORKS INC.

2731 E. WESTMORELAND ST., PHILADELPHIA, PA.



G-E gear-motors are designed for simple compact, low-speed installations

G-E splash-proof motor

G-E single-phase sleeve-bearing, repulsion-induction motor for small drives

G-E synchronous motor for low-speed, direct-connected drives

New G-E disk-type brake, mounted on motor, suitable for controlling small hoists and winches

G-E combination magnetic switch—a line switch and a magnetic starter under one cover

General Electric close-coupled turbine-gear sets provide both power and low-pressure steam for processing

G-E magnetic, full-voltage synchronous-motor controller

G-E manual motor-control switch for full-voltage starting of small motors

G-E vertical, protected-type, induction motors are especially designed for deep-well pumping

G-E squirrel-cage induction motor, with pulley and sliding base

Whatever your

Power-transmission Problem

General Electric Apparatus and Service Will Help You Obtain Full Value from Your Investment

YOU'LL find that General Electric's complete service offers important advantages that save you money.

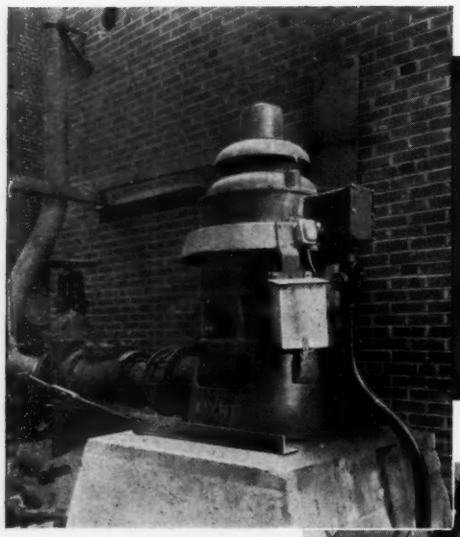
Everything electric from one manufacturer—from wire, cable, motors, control, to the largest power and generating apparatus—simplifies purchasing and assures you that both installation and service will be handled efficiently and economically.

Valuable assistance in solving your electrical problems is available to you through a nation-wide organization of electric-equipment specialists. Our nearest office is ready to help you.

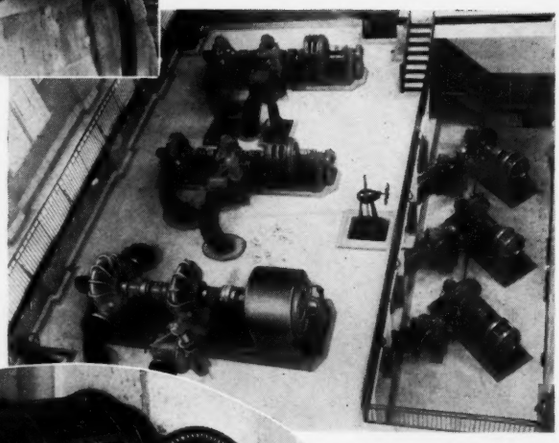
The quality of G-E materials and workmanship is your assurance of equipment that will give dependable service at low maintenance. General Electric Company, Schenectady, N. Y.

GENERAL ELECTRIC

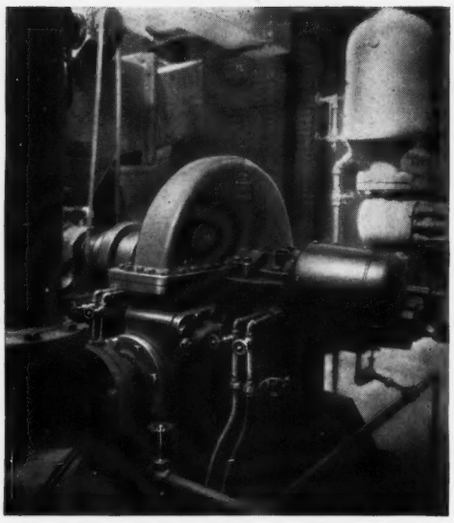
G-E Equipment Solves Drive Problems of Every Type



Direct-connected to a deep-well pump in the Philadelphia plant of the Continental Distilling Corp., this G-E vertical motor is doing an efficient, money-saving job

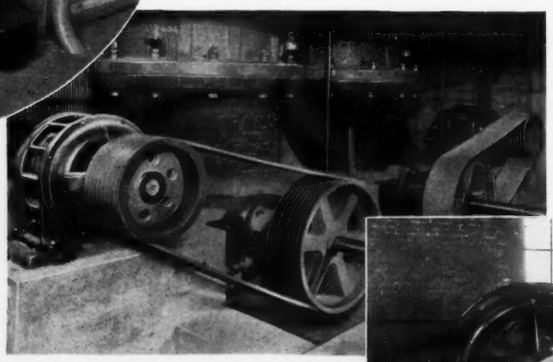


Six pumping units in the new Lakewood Pumping Station at Duluth had six different motor and control requirements. General Electric supplied the right equipment for each unit

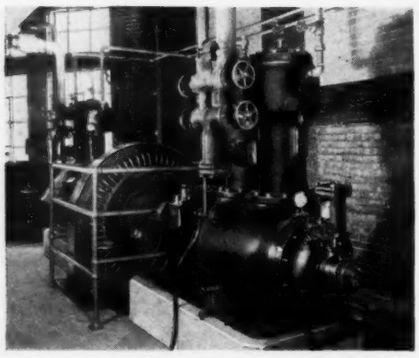


Coupled to an impact coal pulverizer, this G-E mechanical-drive turbine is installed in the power plant of a large paper mill. For power-plant auxiliaries, this type of drive offers simplicity and economy of operation

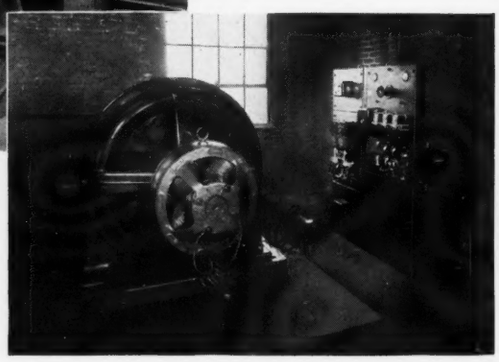
Where it is desirable to eliminate noise and vibration, G-E quiet motors on sound-isolating bases provide quietness and smoothness of operation



Employed as a ventilating-fan drive by the Powhatan Mining Co., Powhatan, O., this G-E 200-hp. synchronous motor saves the user $4500 annually through improved power-factor



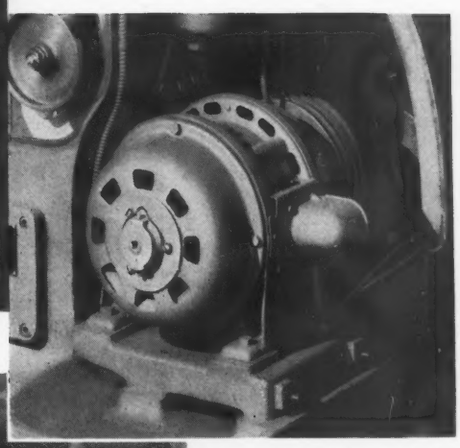
Operating finishing crushers in a large crushed-stone plant, these two G-E induction motors, with G-E control, give dependable, uninterrupted service that means low operating costs and greater profits



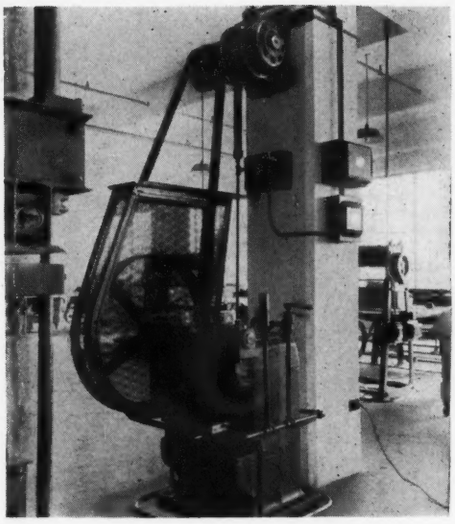
Direct-connected to two ammonia compressors in the Pilsener Brewing Co. plant at Cleveland, this 200-hp., 300-rpm., G-E synchronous motor supplies a dependable, economical answer to an important drive problem

GENERAL

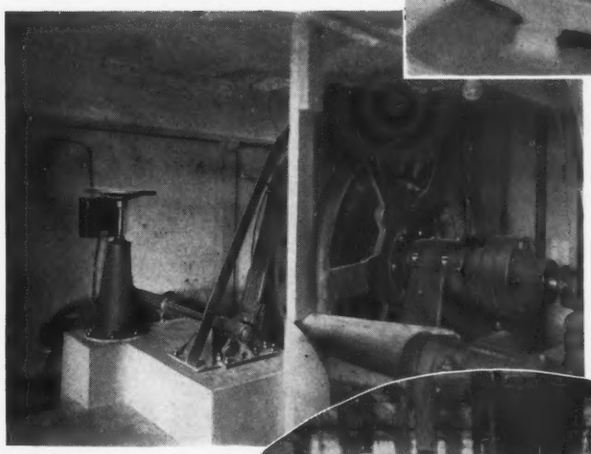
Electric Problems in Every Industry



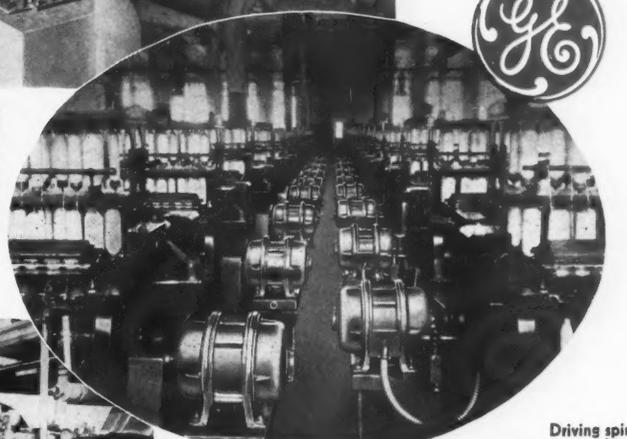
As drives for machine tools in thousands of industrial plants, G-E motors and control give efficient, dependable service made possible by careful matching of motors and control to individual machine requirements



Providing power for a 75-ton hydraulic press in the National Card Company's New York City plant, this G-E 360-rpm. gear-motor combines reliability and convenience. No countershafts are required; installation is simplified

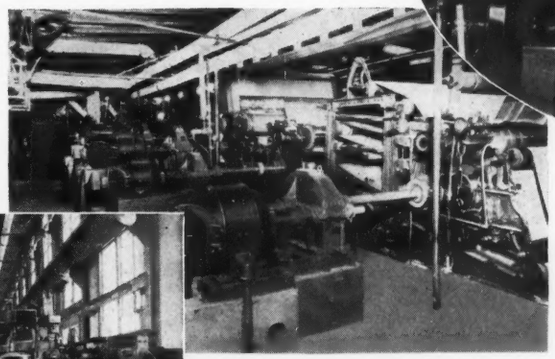


Replacing two induction motors in the 1600-barrel mill of the Weber Flour Mills Company, this G-E 450-hp. Super Synchronous motor reduces power costs $434 a month through improved power-factor. Similar savings are possible in many mills and factories



Driving spinners in a large Southern textile mill, this battery of G-E screenless, open textile motors, with G-E combination magnetic switches, is cutting costs through efficient operation and lowered maintenance

This boiler-drilling machine in a large railroad shop was modernized by overhauling the drill heads and installing new G-E motors and control. Total cost of installation, $16,000; annual savings, $5400 to $27,000, depending on production



Operating paper machines, G-E sectional drives provide distinct advantages of flexibility, plus economy of operation through reduced felt costs

Combining a magnetic starter and a line switch under one cover, G-E combination magnetic switches perform hundreds of control jobs in mills and factories. This type of switch saves space, simplifies operation, and adds to safety

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Wherever you are . . . we can serve you well

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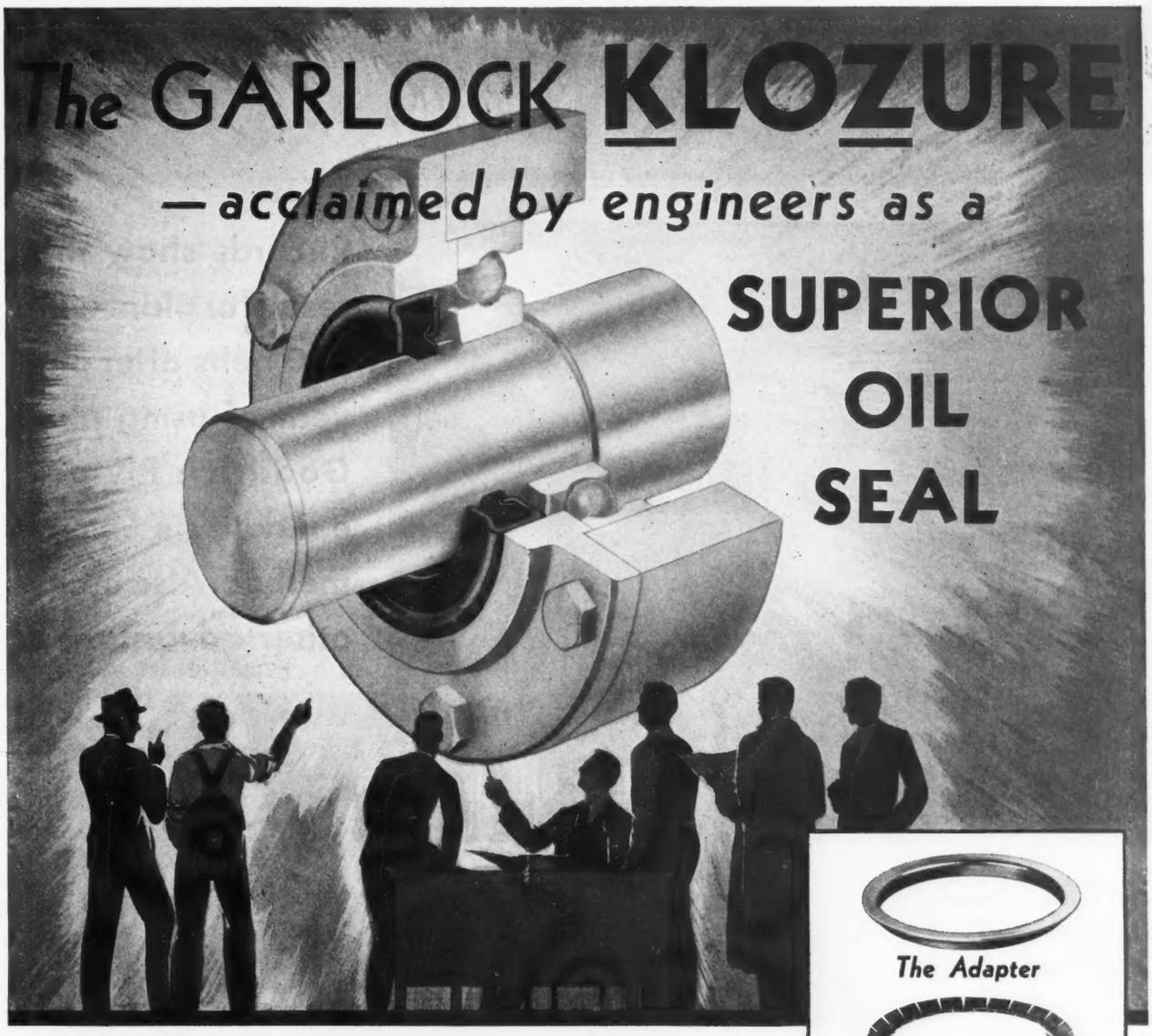
011-29

GENERAL ELECTRIC

Filing No. 8030

The GARLOCK KLOZURE

—acclaimed by engineers as a SUPERIOR OIL SEAL



PATENTED

UNIFORM performance—resistance to oil at high or low temperatures—low co-efficient of friction . . . these are the important features of the Garlock KLOZURE that distinguish it as an extraordinary oil seal.

Consisting of only four parts, the Garlock KLOZURE is as simple in construction as it is dependable in use.

This sturdy oil seal is made in a wide range of sizes. The Garlock KLOZURE will solve your oil seal problems and save money for you!

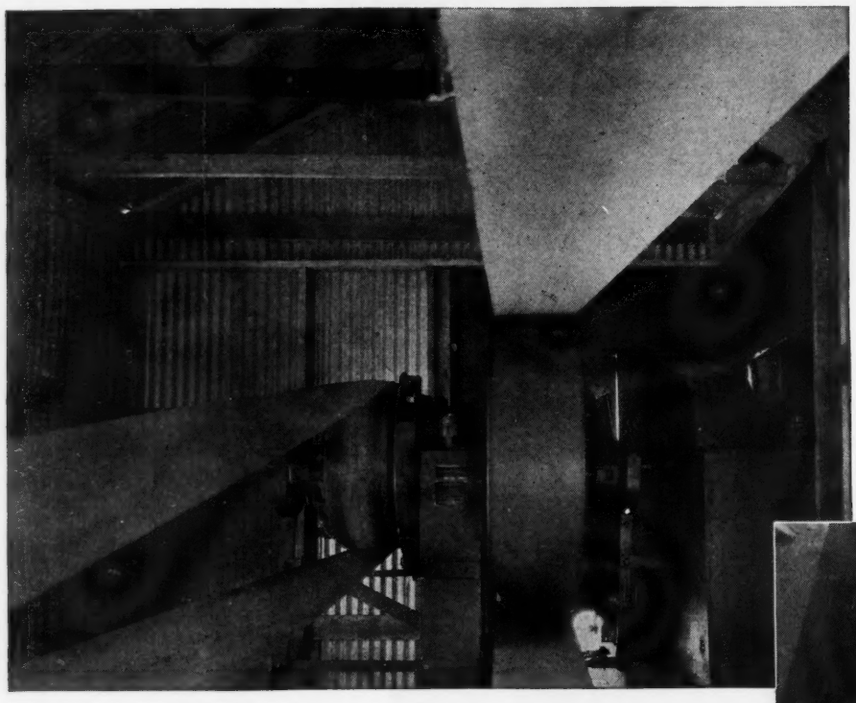
Write for booklet!

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK

In Canada: The Garlock Packing Company of Canada, Ltd.
Montreal, Quebec

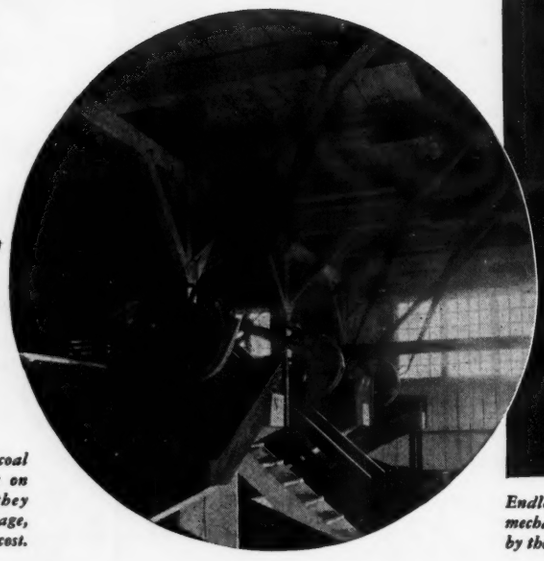
GARLOCK

50% Longer Belt



Records show this result for plant with 300 belts after one year of using new Goodrich Plylock endless belt method. Also many other advantages.

In the oil fields a single belt failure may be extremely costly. Many oil companies have standardized on endless Highflex because it lasts so long, often 50% longer than any other belt.



ALL *products problems* IN RUBBER

Endless Highflex Belts in a coal washery which standardizes on these endless belts because they maintain tension, reduce slippage, last longer and reduce belt cost.

Endless Highflex on the crusher drives of a western mine. Any mechanic can learn in an hour or two how to make belts endless by the new Goodrich Plylock method.

Goodrich

Life at ½ the Cost

● Every user wants endless belts. But they have always been too cumbersome to apply, or have taken too long to secure, or have required dismantling of machinery.

Goodrich set out to develop a practical method of making belts endless—and the Plylock Splice* and a portable electric vulcanizer gave the answer.

Before public announcement, this revolutionary method has been tested in many plants. One, with 300 1¾-inch belts, had tried rubber, but because of extreme tension necessary, fasteners could not be used and the best splice then available failed in a week. So engineers had standardized on a special premium leather belt which lasted 2 weeks, was respliced, lasted 4 months, was rebuilt and then lasted 6 weeks. A total for the best leather of 6 months at the most.

With their fingers crossed, the engineers in this plant tried Highflex, made endless on the machines with the new Plylock Splice and electric vulcanizer. They have just taken off the original belts—after 9 months without a single shut-down or one moment's attention.

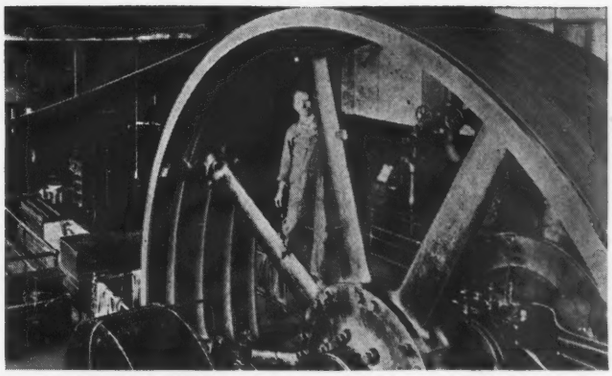
Now every one of the 300 belts is Highflex, each vulcanized on the drive in 45 minutes. Highflex costs less than ½ as much as the leather they had used, gives them 50% more life, saves the time of one man formerly required to remake leather belts, and increases output by reducing idle machine time.

Piece-work employees at this plant had demanded an increased scale. Since using endless Highflex there has been no belt failure, so output is up, employees are happy, and there has been no more talk of an increased scale.

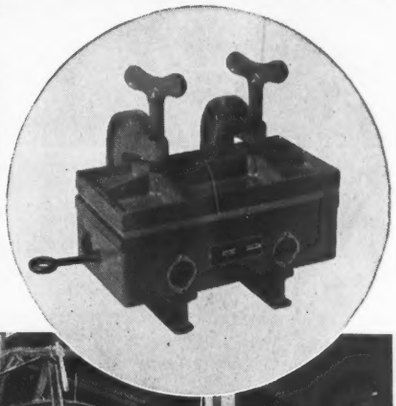
Look at the Plylock Splice and you'll see why it eliminates belt trouble. The outside seam (which was where endless belts failed) is turned under the surface, so that strain and windage cannot get at it.

Any Highflex Belt can be made endless by the Plylock method. You pay no premium—the only cost is the vulcanizer (from $45 up) or a reasonable charge if your Goodrich Distributor uses his equipment (most of them already have it) in his shop or at your machine. Call your Goodrich Distributor today, and start saving money. The B. F. Goodrich Company, Mechanical Rubber Goods Division, Akron, Ohio.

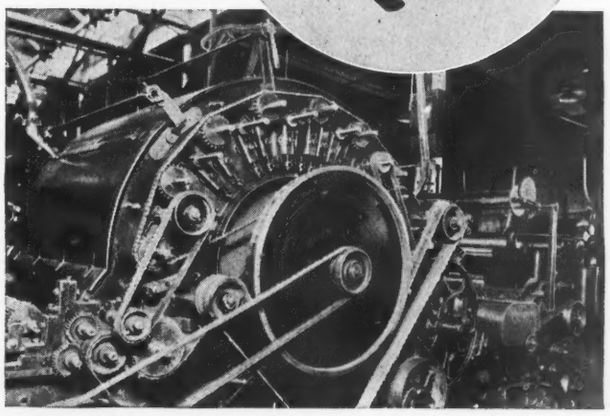
* Patent applied for.



There is no drive too big for endless Highflex. For very wide belts special vulcanizers are shipped from the factory with expert mechanic to vulcanize belts endless on the pulleys.



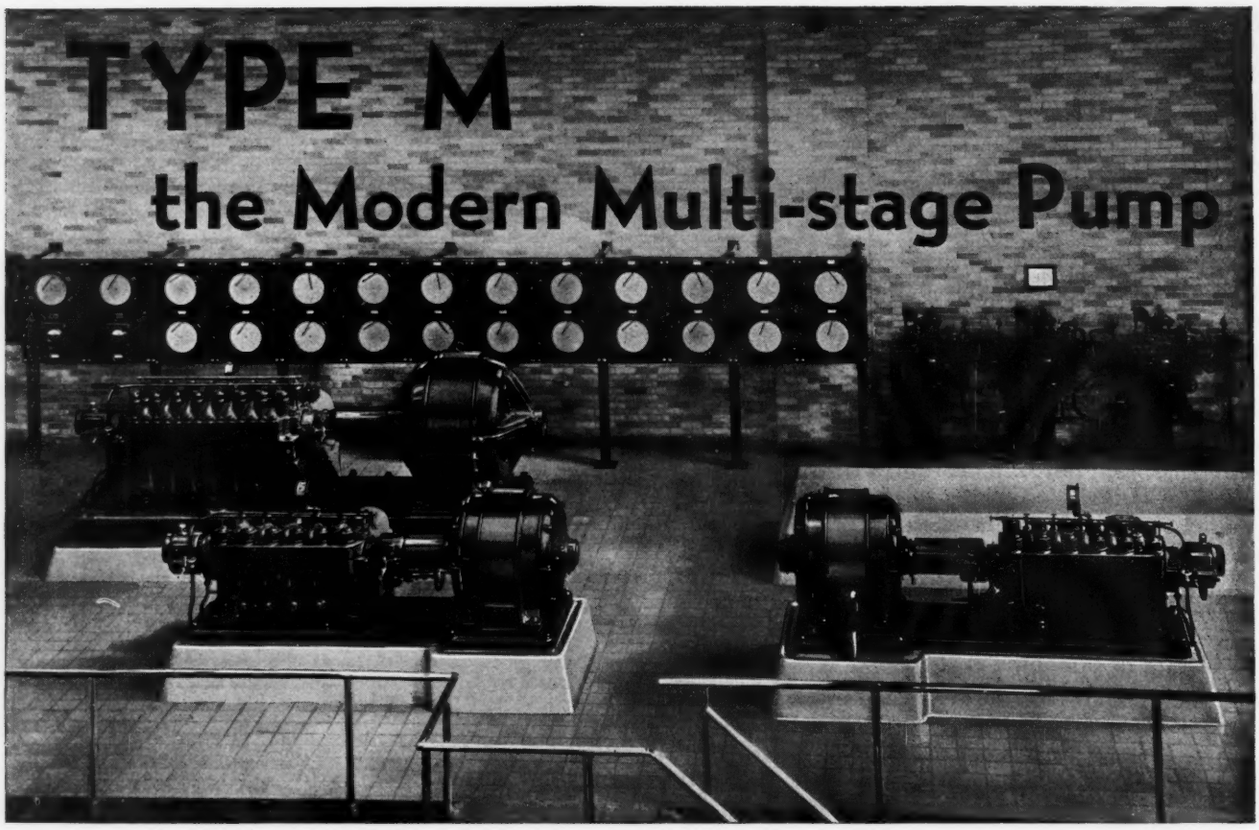
Portable Vulcanizer used in making Highflex endless, quickly and inexpensively, on the job. The size shown, for A. C., sells for $45 and will vulcanize any rubber belt up to 5" in width. Models are available for both A. C. and D. C. installations, and in larger sizes for larger belts.



Wherever endless belts are possible in textile mill operations, you will find Highflex, the belt that does not relax under tension.

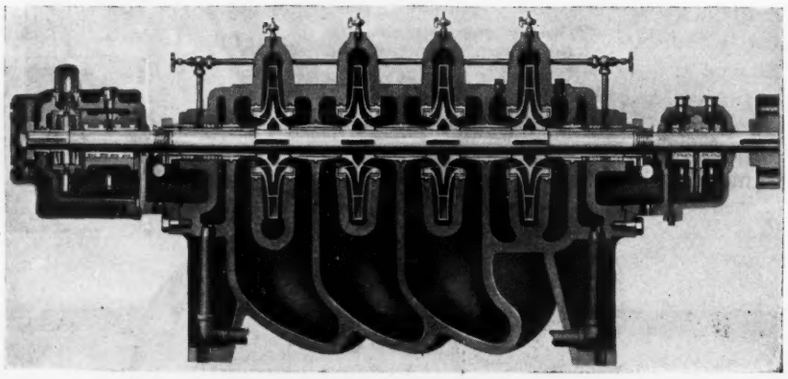
Highflex Belting

We're so proud of Highflex that we give it a permanent brand—the *red edge*—the mark of the belt with the 14 new improvements.



. . . They are Well Worth the Money

THE Allis-Chalmers Type "M" high pressure DOUBLE SUCTION multi-stage centrifugal pump has exclusive advantages which insure economy of operation and maintenance. It has the simplicity and efficiency of the single stage double suction pump in multiple stages combined in a single casing with integrally cast water passages . . . no diffusion vanes to wear and lose efficiency . . . a simple air cooled Kingsbury thrust bearing . . . hydraulic balance without internal balancing devices . . . liberal inlet area into the impellers but without high speed of the inlet edges of the vanes due to the double suction impellers. Substantial bolting making tight joints between stages. These are the reasons why the type "M" pump is meeting with more and more favorable consideration in boiler feed and similar service.



A type "M" pump installed in Ironwood, Michigan, to pump against 630 feet head saved more than twice its cost in the first year which is a striking example of an economy that quickly offsets any slightly higher cost over less modern pumps.

Write for bulletin 1642B.

ALLIS-CHALMERS

— Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin, U.S.A. —

Need low-pressure steam?

These G-E extraction turbines for mechanical drive will save you money

BY INSTALLING a small G-E extraction turbine for driving a pump, a fan, or similar machine, you can easily make real savings in fuel cost. The extracted steam performs a double service. First, it produces power by passing through part of the turbine; then, on being extracted from an intermediate stage, it provides a constant-pressure source of steam for process or heating.

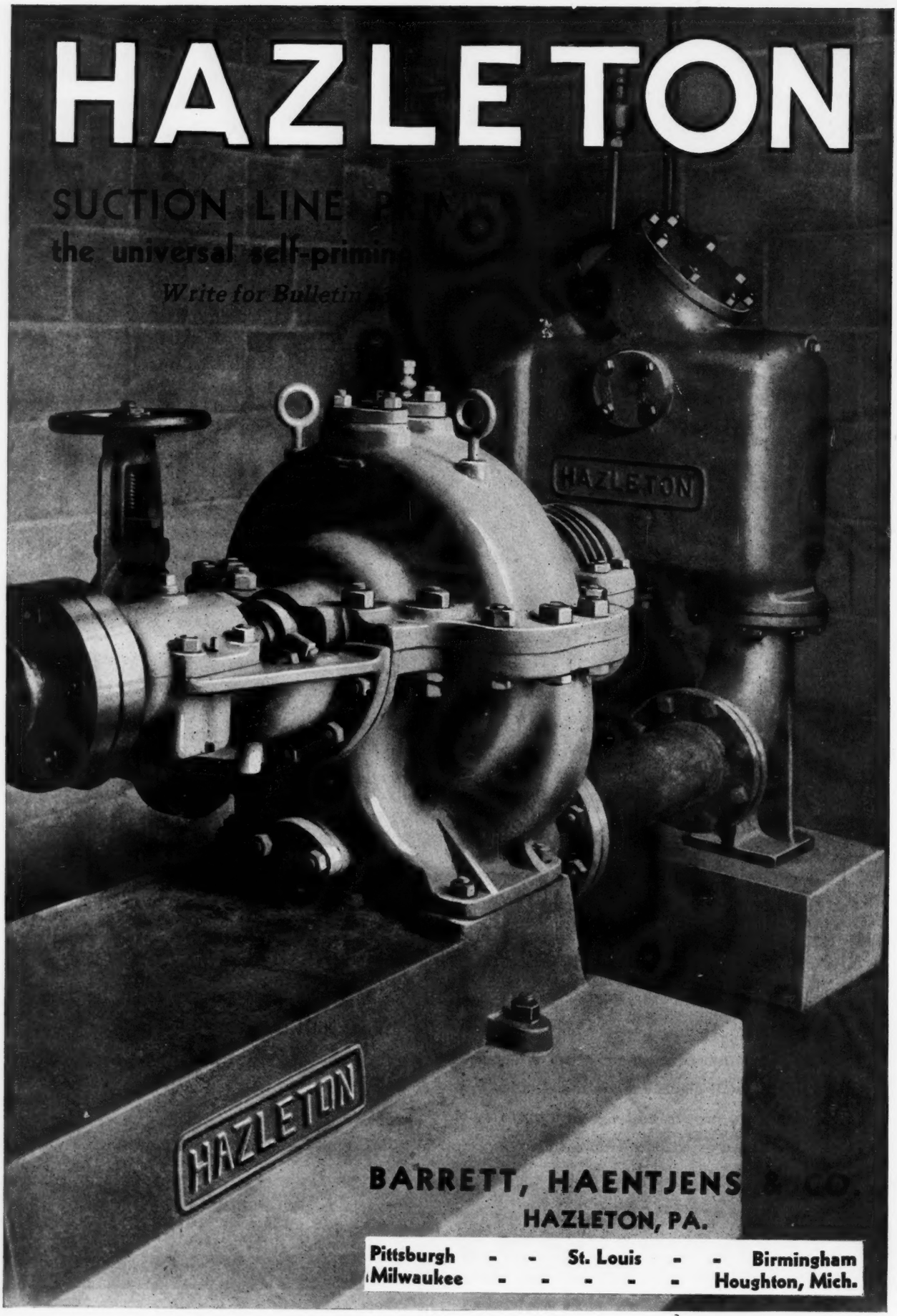
General Electric manufactures a complete range of sizes of extraction turbines to meet almost any requirements of steam demand or power output. A G-E turbine specialist will gladly explain the advantages of G-E turbines and assist you in selecting the proper unit for your requirements. For particulars, call the nearest G-E office or write to General Electric, Dept. 6A-201, Schenectady, N.Y.

For

PUMPS
FANS
COMPRESSORS
BLOWERS
LINE SHAFTS
GENERATORS

720-227

GENERAL ELECTRIC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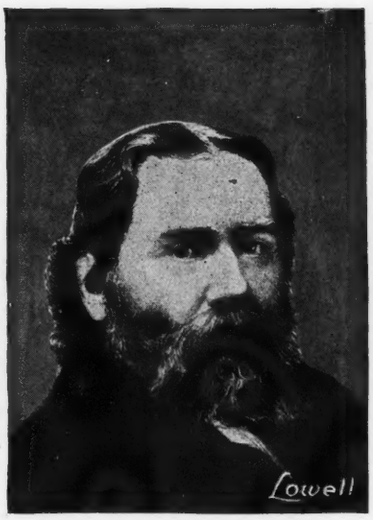
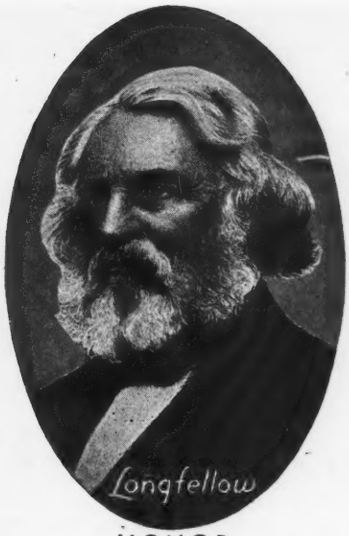


EXPERIENCE
May Issue



HONOR
November Issue

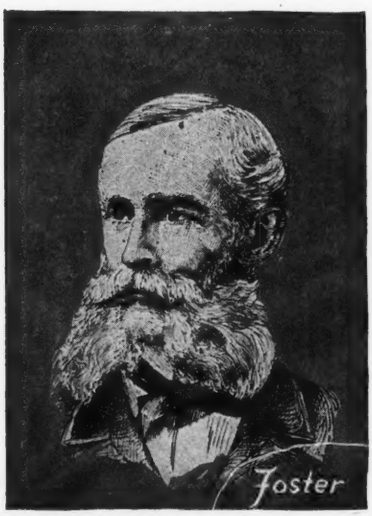
QUALITY
December Issue

FIRMNESS
October Issue

A Friendly Christmas

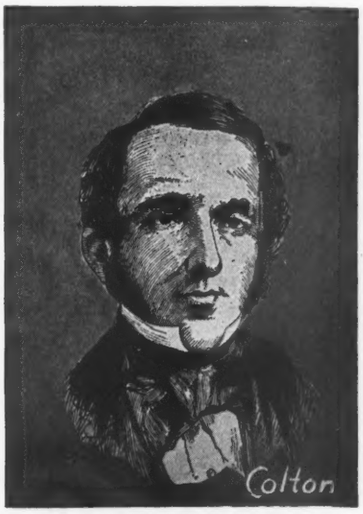
THE SUPERHEATER COMPANY
THE AIR PREHEATER CORPORATION
60 East 42nd Street, New York

CONFIDENCE
June Issue



KNOWLEDGE
July Issue

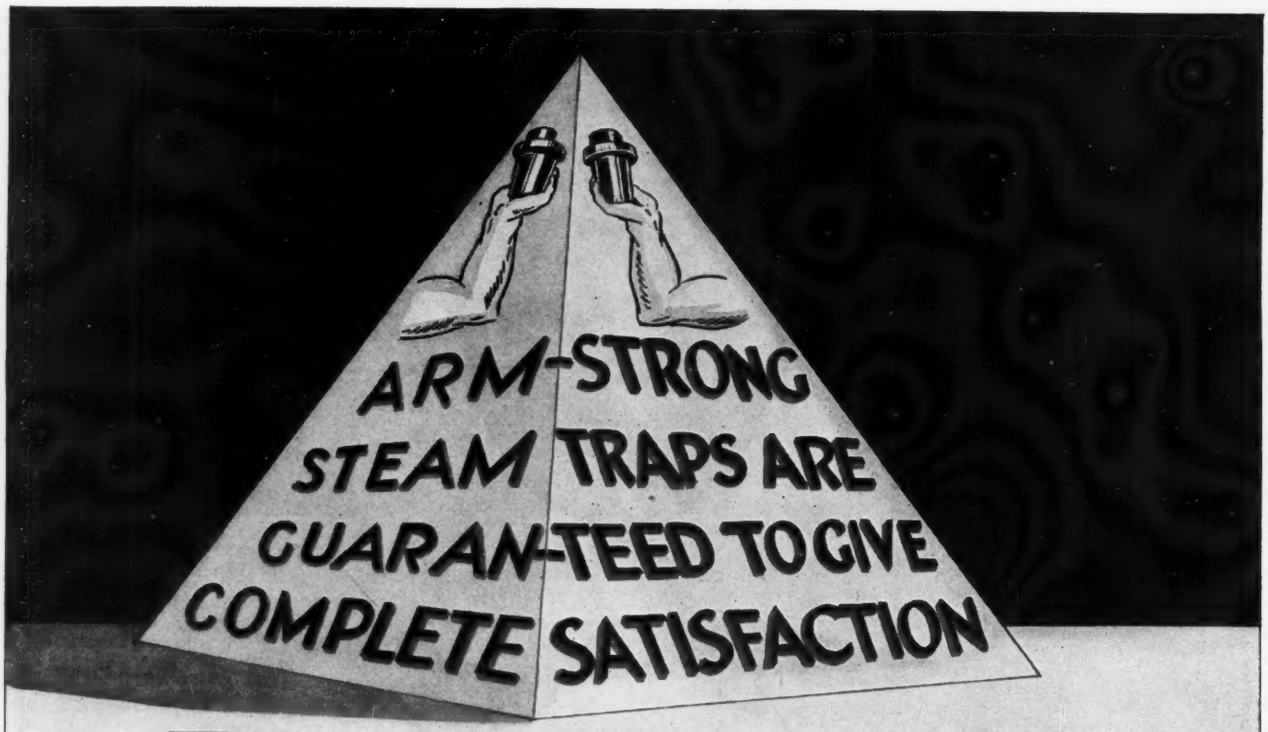
BUSINESS MORALS
August Issue



PROVED PRINCIPLES
September Issue

A-933

SUPERHEATERS • AIR PREHEATERS • GRIFFIN HOT BLAST • WATER WALLS • ECONOMIZERS



FOR more than 20 years this simple statement of policy has stood unchanged. It has proved a stable factor both in prosperity and depression. Armstrong Traps give satisfaction (1) because they have steadily pioneered new features of design; (2) because they are built to the highest standards of quality; (3) because the service organization is competent and readily available to all users; (4) because they are rated accurately and provided in types to meet every operating condition and (5) because the whole organization takes the guarantee seriously. It is natural that such a policy should have maintained this trap in a position of leadership in its field for many years. The 90 days' free trial—which Armstrong originated in the sale of steam traps—still holds good. It enables you to prove the "complete satisfaction" which is offered.

ARMSTRONG MACHINE WORKS
812 Maple Street Three Rivers, Michigan

ARMSTRONG · INVERTED BUCKET · STEAM TRAP

Controlled Water:

IF ALL damage being caused by uncontrolled water were as visible as this, you would heartily agree with us when we say that it pays to get the best possible protection whenever you deal with water. Unfortunately, in the case of steam boilers, the ravages of uncontrolled water are often hidden from view until after the damage is done. In order to be protected against such losses, nearly 3,000 plants are now using the Nalco System of feed water control.

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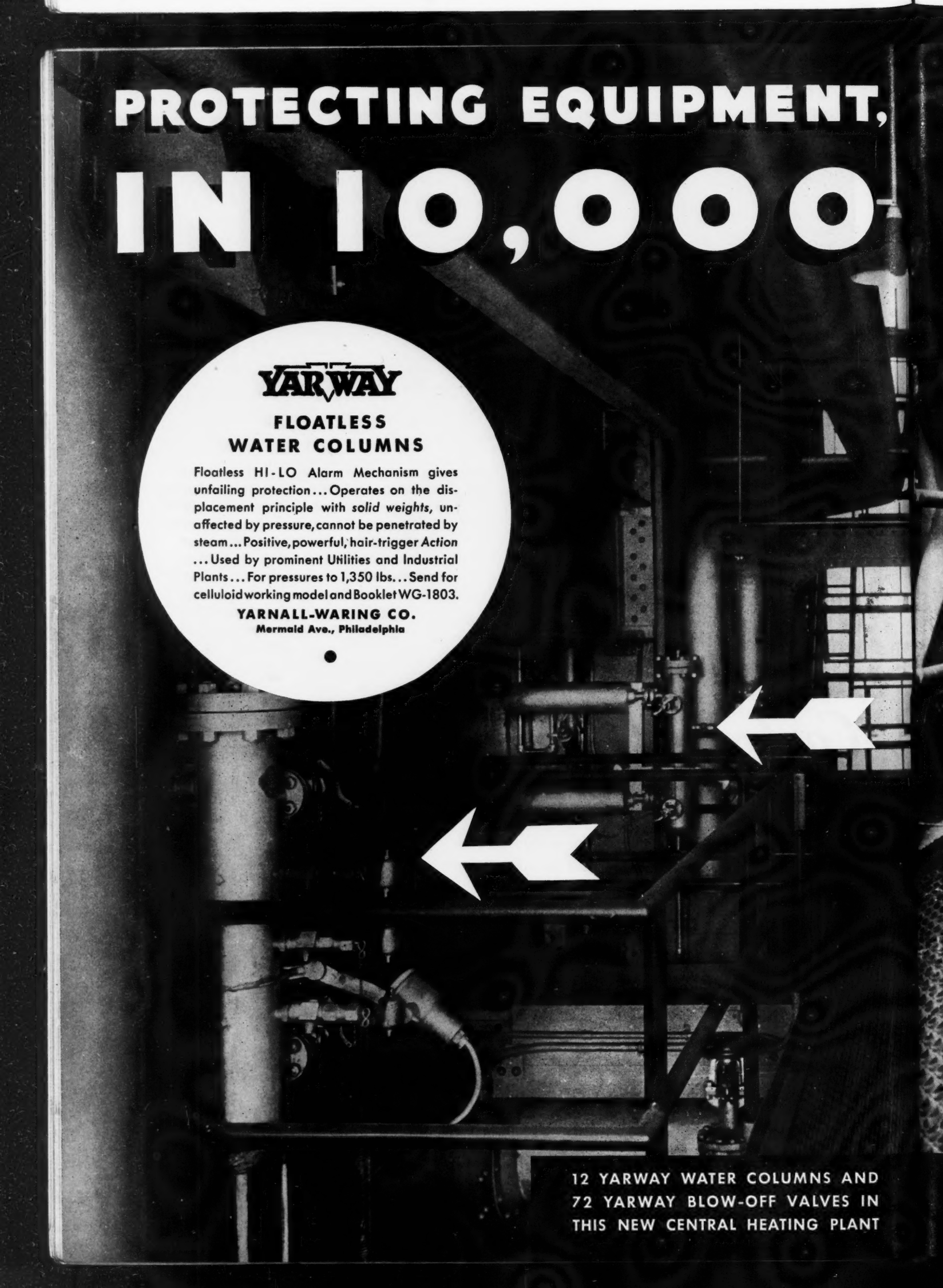
PROTECTING EQUIPMENT, IN 10,000



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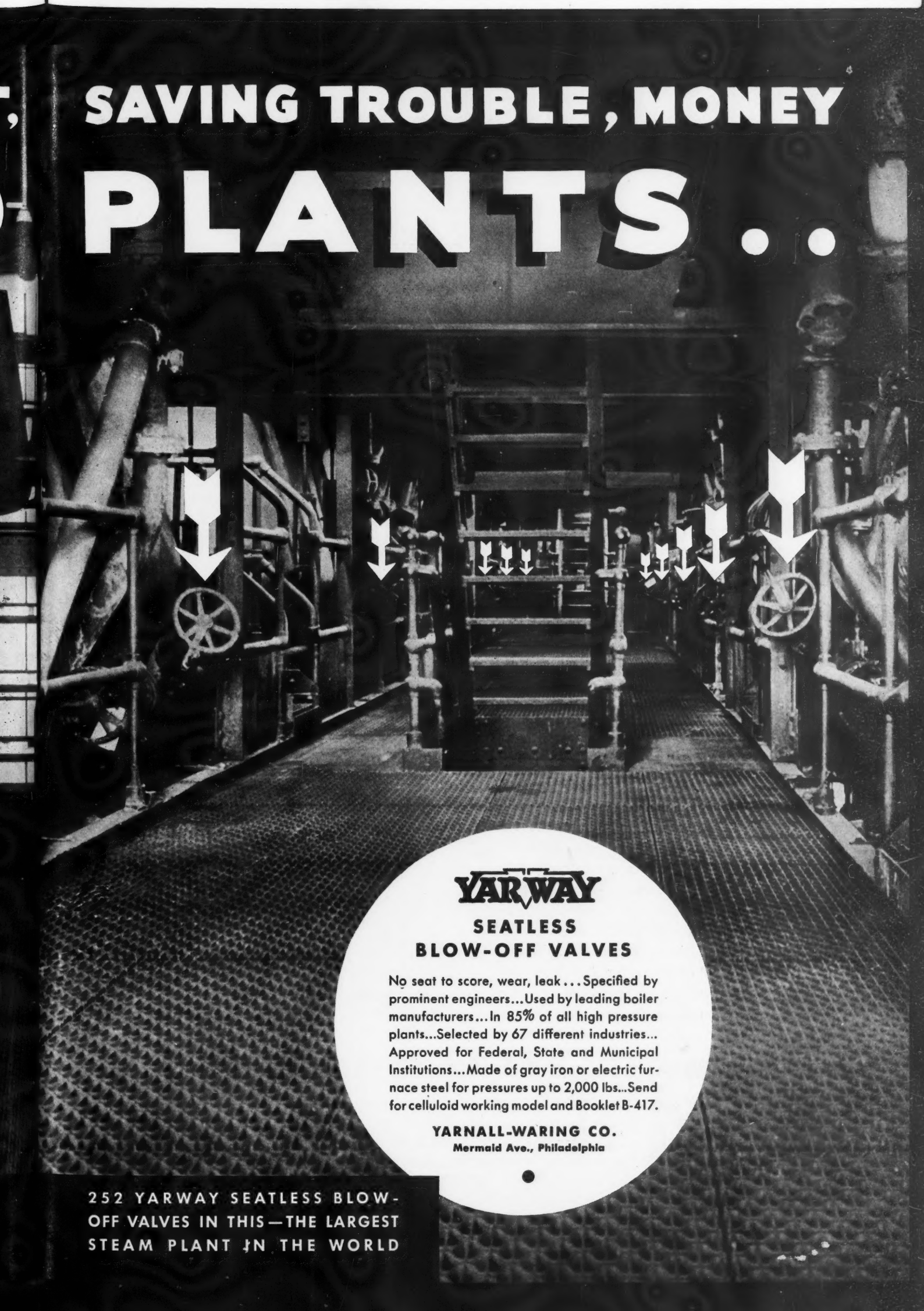
Floatless HI-LO Alarm Mechanism gives unfailing protection... Operates on the displacement principle with *solid weights*, unaffected by pressure, cannot be penetrated by steam... Positive, powerful, hair-trigger *Action* ... Used by prominent Utilities and Industrial Plants... For pressures to 1,350 lbs... Send for celluloid working model and Booklet WG-1803.

YARNALL-WARING CO.
Mermaid Ave., Philadelphia

12 YARWAY WATER COLUMNS AND 72 YARWAY BLOW-OFF VALVES IN THIS NEW CENTRAL HEATING PLANT

SAVING TROUBLE, MONEY

PLANTS . .



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No seat to score, wear, leak . . . Specified by prominent engineers . . . Used by leading boiler manufacturers . . . In 85% of all high pressure plants . . . Selected by 67 different industries . . . Approved for Federal, State and Municipal Institutions . . . Made of gray iron or electric furnace steel for pressures up to 2,000 lbs . . . Send for celluloid working model and Booklet B-417.

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Mermaid Ave., Philadelphia

252 YARWAY SEATLESS BLOW-OFF VALVES IN THIS—THE LARGEST STEAM PLANT IN THE WORLD

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PRODUCTION FACILITIES

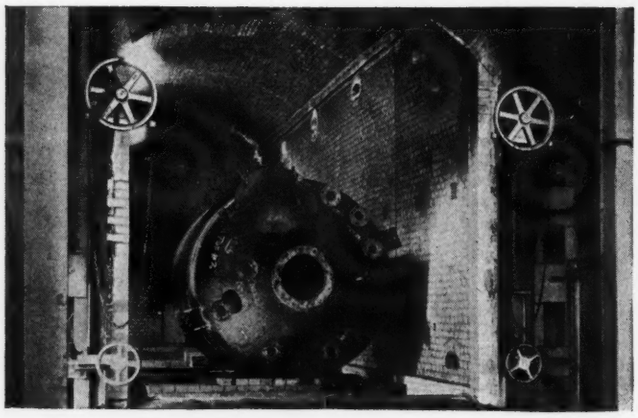
Behind Edge Moor's engineering skill, gained through more than a half-century of experience in boiler and pressure vessel design, stands four acres of fully modernized shops.
Here the most advanced equipment and technique is employed for fabrication, on a production basis, of the broad range of standard and special equipment built by this company.

FUSION WELDING

Modern method of fabrication developed to a high degree of efficiency at Edge Moor. This method of fabrication increases strength, facilitates flexibility in design and reduces weight and cost.

STRESS RELIEVING

Giant stress relieving furnace at Edge Moor will accommodate boiler drums much larger than any in use today. Twenty pyrometer-controlled oil burners, with full automatic operation, maintain any desired temperature in the furnace within 10° above or below the set point. Floor of furnace rolls out on special track for loading in the plant.



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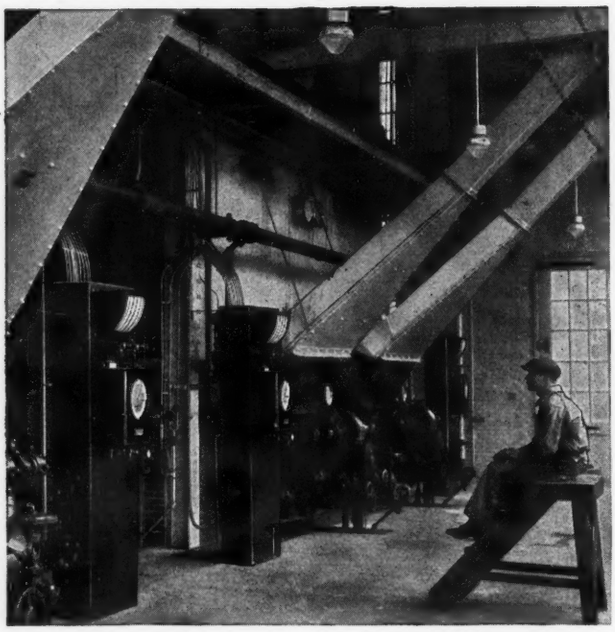
X-RAY INSPECTION

300,000 volt x-ray machine in the Edge Moor shops. This machine, situated below the floor, permits a special railroad truck for handling the welded vessels to be quickly rolled into position for photographing. Capable of "looking through" 4¼ inches of metal, this machine's capacity is second to none in commercial use today.

BUILDERS OF • WATER TUBE BOILERS in a wide range of types and sizes to suit almost any given set of conditions • STEAM PLANT AUXILIARIES — water walls, air preheaters, superheaters and economizers • HEATING BOILERS — fully automatic gas and other forms of heating • WASTE HEAT RECOVERY SYSTEMS for all types of industrial applications and for recovery of heat from internal combustion engine exhaust • PRESSURE VESSELS — all types of fusion welded pressure vessels for the oil refining industries, chemical industries, food industries, and for special processing • CHROME, NICKEL and other ALLOY FABRICATION, welding and heat-treating.

Modern Boiler Room Design Includes

Bailey Meters and Control



Bailey Meters and Control installed on three 400 h. p. B & W Boilers at Sunny Brook Distillery, Louisville, Ky.

Any boiler plant modernization program, however limited it may be, should include the installation of metering equipment to secure the most efficient operation possible from each unit. Regardless of whether existing equipment is revamped or new boilers are purchased, maximum economy from each unit should be insured by a Bailey Boiler Meter to guide manual or automatic combustion control.

Bailey Meter Control of combustion is a highly profitable investment for boilers even as small as 200 h.p. The relatively small outlay required is quickly returned by increased uniformity of operation which results in fuel savings, greater safety and decreased maintenance.

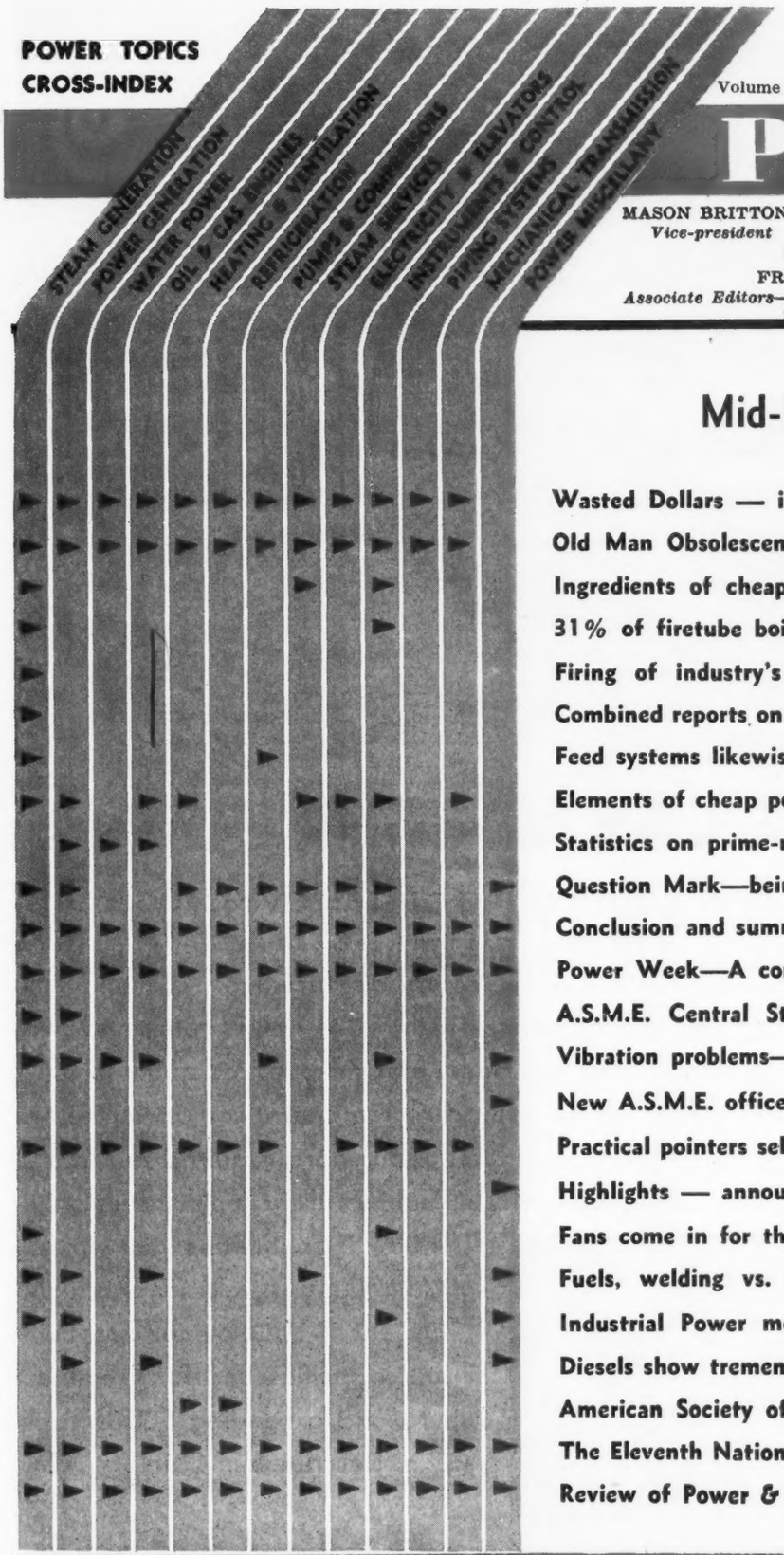
Regardless of the fuel or method of firing, if your boilers are 100 h.p. or larger, it will pay you to investigate the savings which can be effected by modernizing your boiler room with Bailey Meters and Control. Write for Bulletin No. 44-A which cites over twenty examples of savings effected by the use of Bailey Boiler Meters.

D-27

Send for this New Bulletin

Bailey Meter Company

1036 Ivanhoe Rd., Cleveland, Ohio
Bailey Meter Co. Ltd., Montreal, Can.



Volume 78 Number 13

POWER

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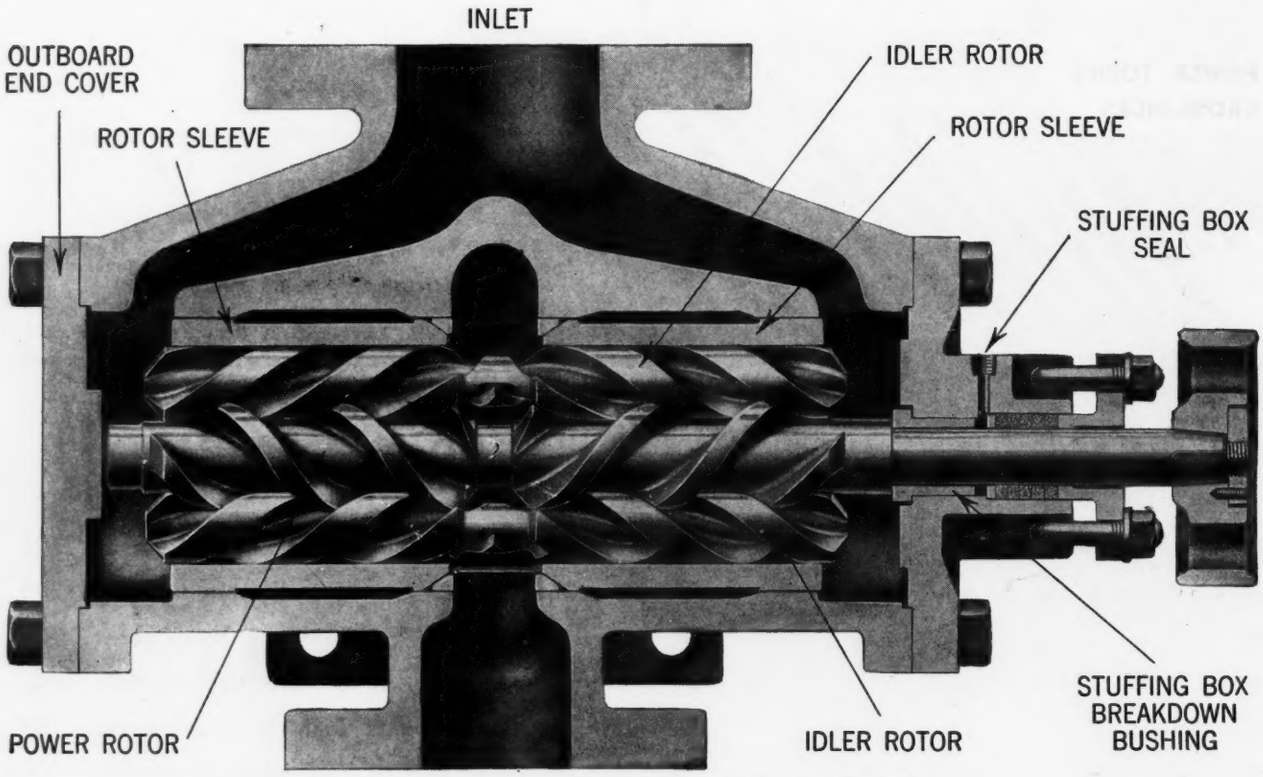
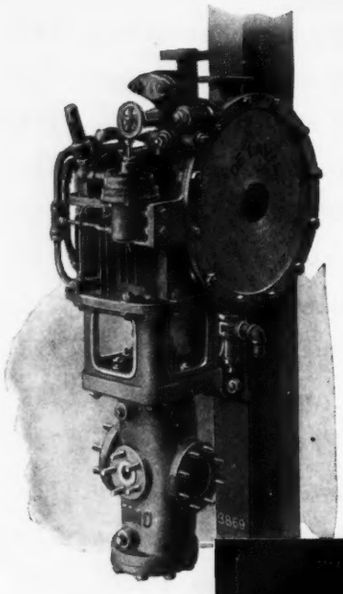


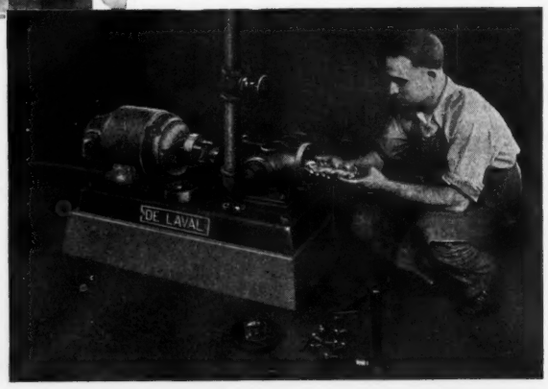
Axial section of pump



ABOVE—Pump driven through worm gear by efficient high speed turbine.

•

AT RIGHT—Motor driven pump; the three moving parts are easily accessible without disturbing piping



1-8

DE LAVAL-IMO PUMPS

for Fuel, Lubricating and Heavy Crude Oils

THE IMO PUMP is of the rotary displacement type and has but three moving parts, a central or power rotor and two sealing rotors. Drive can be by electric motor or steam turbine directly connected or geared to the central or power rotor. No timing gears or separate bearings are required and there is but one stuffing box, which is subject to suction pressure only. The flow is continuous and without pulsation and the efficiency is high.

De Laval-IMO pumps are built in all capacities and for pressures up to and exceeding 500 lb. per sq. in. Described in Catalog L-24.

•

DE LAVAL STEAM TURBINE CO., TRENTON, N. J.

Manufacturers of Steam Turbines, Centrifugal Pumps, Propeller Pumps, Rotary Displacement Pumps, Centrifugal Blowers and Compressors, Worm Gears, Helical Speed Reducing Gears, Hydraulic Turbines, Flexible Couplings and Special Centrifugal Machinery. Sole Licensee of the Bauer-Wach Exhaust Turbine System.

FLOATING COIL CLAMP . . . .

The full floating clamp on the helical coil of the Mason-Neilan Recording Thermometer permits free radial and axial expansion . . . transmits only the true *angular* rotation to the pen . . . eliminates friction and lost motion. Temperature records, inscribed on easily-read 12-inch charts, are unfailingly accurate . . . provide you with the facts you need to increase plant efficiency and safeguard your products' excellence. Install these new Mason-Neilan Recording Thermometers and know just what your processes are doing. Write for bulletin No. 3076.

MASON-NEILAN REGULATOR CO., 1190 ADAMS STREET, BOSTON, MASS.
Agencies in All Principal Cities

MASON-NEILAN

PRESSURE • TEMPERATURE • FLOW CONTROL

WATER TREATING EQUIPMENT

For Every Purpose

● For over twenty years, our engineers have studied the problem of water treatment for modern industry. As a result of their findings, we have developed up-to-date equipment for every industrial use where effective water treatment can bring you new economies. As further assurance of savings, this equipment has been designed to operate at the lowest possible cost.

Our plan to help you save money by proper water treatment has proved a success. Our records show that practically all the Permutit equipment now in use has *paid for itself in actual savings*, usually within two years.

Let Permutit save *you* money. We will gladly send you, free of charge, detailed information on any product you wish to know more about. Simply ask for the booklet. Write The Permutit Company, 330 West 42nd Street, New York City.

PERMUTIT PRODUCTS

Equipment for removing hardness from water:

(1) Zeolite Water Softeners. (2) Hot Process Lime Soda Water Softeners. (3) Continuous Lime Soda Water Softeners. (4) Intermittent Lime Soda Water Softeners. (5) Lime Barium Water Softeners.

Equipment for removing other impurities dissolved in water:

(1) Zeolite Type Iron and Manganese Removal Filters. (2) Chlorine (Free) Removal Equipment. (4) Color Removing Equipment. (5) Activated Carbon Filters.

Equipment for removing impurities suspended in water:

(1) Filters for Clarifying Water. (2) Oil Removing Filters. (3) Mechanical and Chemical Type Iron and Manganese Removal Filters.

Equipment for feeding chemical solutions to water:

(1) Automatic Apportioning Pressure and Gravity Feeds.

Continuous Blowoff Systems:

(1) For boilers. (2) For evaporators.

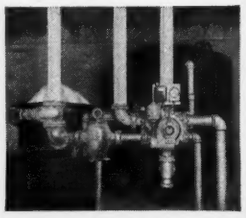
Heat Exchangers:

Ranarex Gas Density Machines:

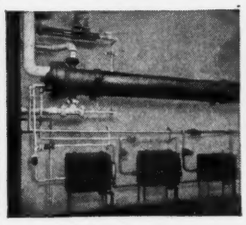
(1) For Determining CO_2 in Flue Gas. (2) For Measuring Specific Gravity of Illuminating Gas. (3) For Determining Ammonia in Ammonia-Air Mixtures. (4) For Determining Specific Gravity and BTU in Butane Air Mixtures. (5) For Other Applications Where Gas Density May Be Used as a Guide to Operation.

Permutit

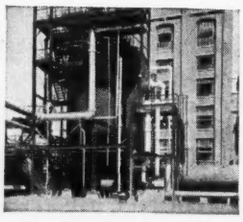
Water Treating Equipment



Permutit Automatic Zeolite Water Softener. Lowers the cost of producing soft water. No overrunning. No under-regeneration. Automatic controls can be applied to existing equipment. Write for "No Scale, No Sludge, No Mud."



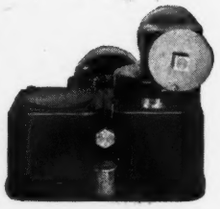
Permutit Continuous Boiler Blowoff Equipment. For continuously maintaining the desired concentration in boilers, with recovery of heat from the blowoff water. Write for "How to Save Fuel and Improve Steam Quality with Permutit Continuous Boiler Blowoff Equipment."



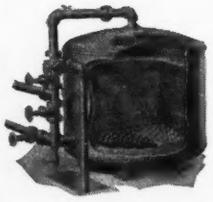
Permutit Hot Lime Soda Water Softener. For reducing total solids, particularly in waters of high bicarbonate hardness. Write for "Hot Lime Soda Water Softening."

Co_2 *Indicators and Recorders.* Ranarex . . . the fully mechanical CO_2 Indicator and Recorder. Strong, rugged, yet with accuracy of 0.3% Co_2. Normal time lag of less than one minute. Fuel savings quickly return its cost. Write for bulletin describing operation.

Heat Exchangers. Turbulence scrubs off stagnant water film from surfaces, permits higher rate of heat transfer. Design allows for unit increases in capacity. Uni-metal construction avoids electrolytic corrosion. Ask for information.



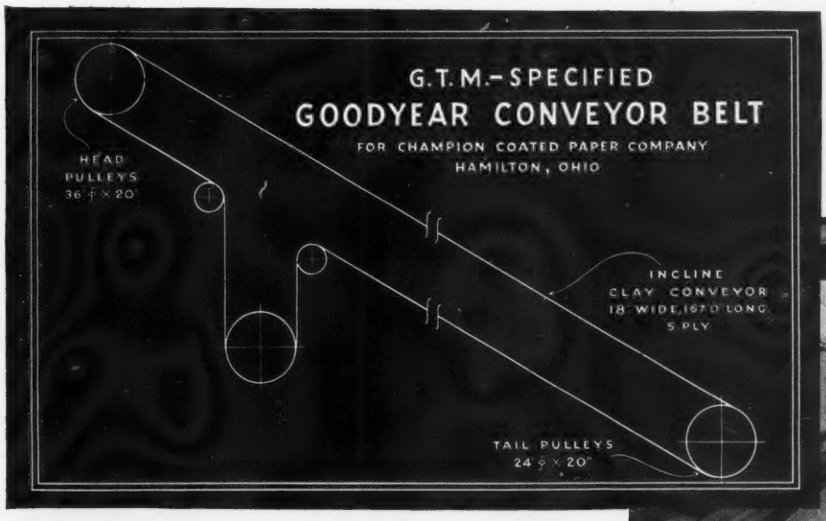
Chemical Feeds For feeding sulphates, phosphates, and other solutions in exact proportion to flow of water. Also constant flow types. Special acid feeds. Feeds for dry materials such as clay. Bulletins available.



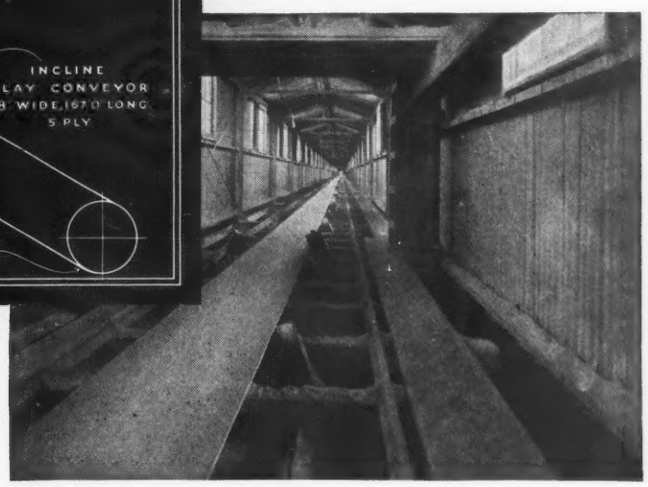
Filters. Both pressure and gravity types, in all sizes . . . for removal of dirt, color, and turbidity. Coagulation equipment. Activated carbon filters for removal of bad taste and odor. Send for a free copy of "Water Filters and Filtration Equipment."

Single Valves. To simplify the operation of zeolite water softeners. Made in all sizes, they can be used with existing equipment. Single valves for filters, too. We'll be glad to send you information and prices.

THE CHAMPIONS OF CHAMPION


G.T.M.-SPECIFIED
GOODYEAR CONVEYOR BELT
FOR CHAMPION COATED PAPER COMPANY
HAMILTON, OHIO
HEAD PULLEYS 36" × 20"
INCLINE CLAY CONVEYOR 18" WIDE, 167'0" LONG 5 PLY
TAIL PULLEYS 24" × 20"

Goodyear Conveyor Belts set record in world's largest coated paper mill



Installed 1920— and still on the job

14 years' service proves value of G.T.M. Specification

IN THE great modern plant of The Champion Coated Paper Company at Hamilton, Ohio, three veteran conveyor belts have quietly proved themselves champions by every test of belt performance.

Back in 1920 the G. T. M. — Goodyear Technical Man — was called to Hamilton. Consulted about belts for the conveying system handling the fine clay used in giving Champion papers satin-smoothness.

Carefully considering all factors the G. T. M. recommended a 5-ply Goodyear Conveyor Belt, 18" wide by 167' long, for the incline conveyor. Another 1372' long for the distributing conveyor, and a third, 14" wide by 1440' long, 4-ply, for the reclaiming conveyor. These belts were built to specification and installed in late 1920 and early 1921.

Today, after rolling on their appointed rounds, day after day, month after month, for some 14 years— after moving nearly seven hundred million pounds of clay — these three belts, while somewhat worn to be sure, are still good for another year of stalwart service.

That's the kind of trouble-free, low-cost, uninterrupted performance you want from belts—and that's what you get when you have belts accurately specified to your operation by the G. T. M., as records in scores of industries prove.

Why not see what this competent expert could do for you. To bring him, write Goodyear, Akron, Ohio, or Los Angeles, California — or call the nearest Goodyear Mechanical Goods Distributor.

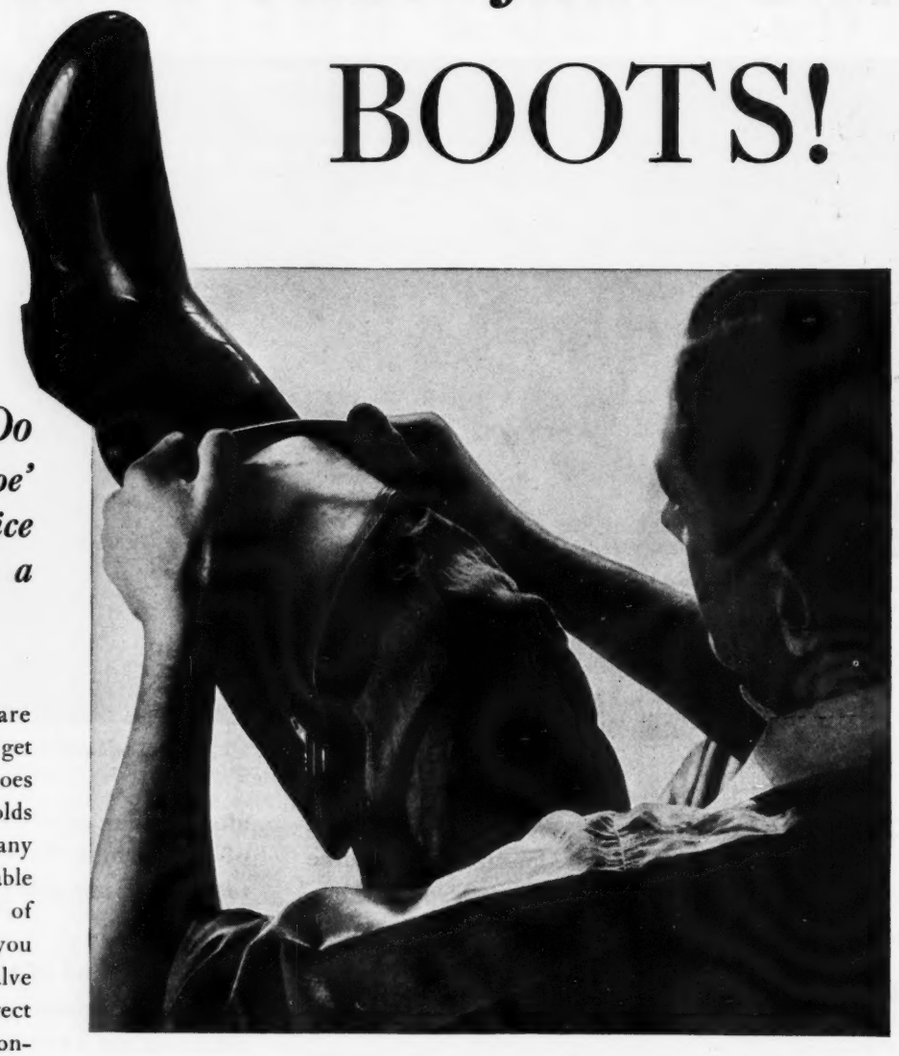
BELTS • MOLDED GOODS
HOSE • PACKING
MADE BY THE MAKERS OF GOODYEAR TIRES

THE GREATEST NAME IN RUBBER

NRA CODE

GOODYEAR

Deep water calls for BOOTS!



Overshoes Won't Do

Nor will an 'overshoe' Disc get the best service out of valves that do a 'hip-boot' job . . .

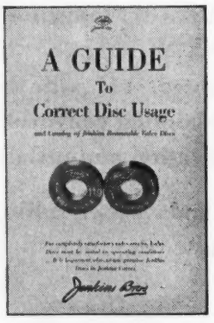
BOTH overshoes and boots are made to keep feet dry. But you'll get wet, sure, if you put on overshoes to go wading. The same thing holds true with valve discs. All of the many different types of Jenkins Renewable Discs have the general purpose of effecting a leak-tight seat. Yet, you can't get completely satisfactory valve service unless you use the correct type of disc for your operating conditions.

When you buy valve discs be specific about the conditions under which the discs must work. It is best to give the "disc compound" number as recommended by Jenkins Bros., in the Guide to Correct Disc Usage. Of course, we've taken it for granted that the only question about picking a valve disc is that of getting the correct type of JENKINS Disc. For, after developing and making them since Nathaniel Jenkins invented the Renewable Disc Valve, we believe Jenkins Discs *should* stand supreme.

JENKINS BROS., 80 White Street, New York, N.Y.; 510 Main St., Bridgeport, Conn.; 524 Atlantic Avenue, Boston, Mass.; 133 No. Seventh St., Philadelphia, Pa.; 822 Washington Boulevard, Chicago, Ill.; JENKINS BROS., Limited, Montreal, Canada; London, England

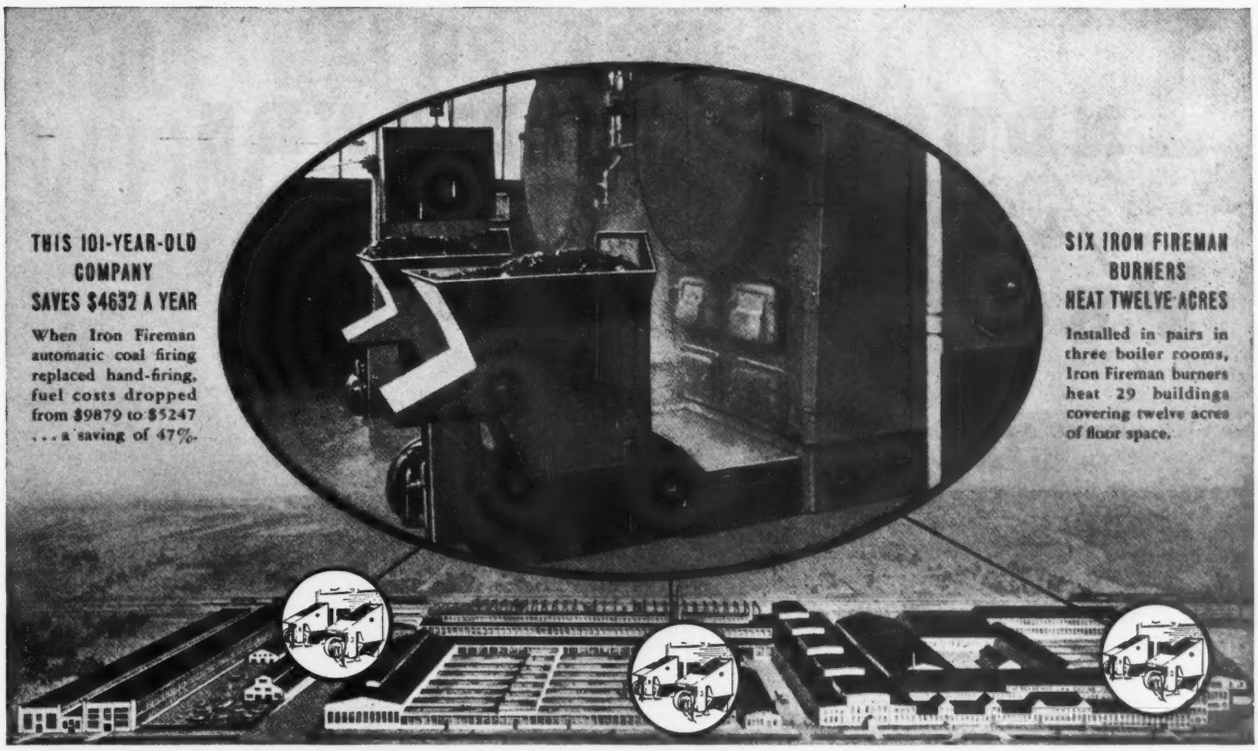
Get this Helpful Guide

We will soon have available a helpful new "Guide to Correct Disc Usage". It opens into a handy wall chart which covers all of the different Jenkins Disc Compounds and shows the services for which they are recommended. This Guide may help you to improve the performance of valves. Write for it now, and we'll send your copy just as soon as it comes off the press.



Jenkins Valves

BRONZE — IRON — STEEL SINCE 1864


THIS 101-YEAR-OLD COMPANY SAVES $4632 A YEAR
When Iron Fireman automatic coal firing replaced hand-firing, fuel costs dropped from $9879 to $5247 . . . a saving of 47%.
SIX IRON FIREMAN BURNERS HEAT TWELVE ACRES
Installed in pairs in three boiler rooms, Iron Fireman burners heat 29 buildings covering twelve acres of floor space.

Six Iron Fireman heavy duty stokers fire the following boilers at the Cooper-Bessemer plant: Two 225 h. p. Pacific boilers; two 175 h. p. Kewanee boilers; two 150 h. p. Pacific boilers.

Iron Fireman cuts fuel costs 47% at Cooper-Bessemer plant

AT Grove City, Pennsylvania, 6 Iron Fireman automatic coal burners are installed in the three boiler rooms of the 12 acre plant of Cooper-Bessemer Corporation, makers of Gas and Diesel engines, Air and Gas compressors.

When Cooper-Bessemer replaced hand-firing with Iron Fireman, season fuel costs tumbled from $9879 to $5247—a saving of $4632 or 47 per cent.

"In addition to this direct money saving," says J. H. Anderson, vice president, "we maintain a more even heat throughout the plant. We have had no shutdowns or troubles of any kind. We are well pleased with the equipment. It has produced all the results claimed by the manufacturer. Savings have been greater than estimated. The burners will have completely paid for themselves from savings in approximately two years."

Iron Fireman automatic coal firing has four advantages that combine to make it a self-liquidating investment: (1) cuts fuel costs 15% to 50%; (2) reduces firing room labor costs to a minimum; (3) provides steady, even heat or power regardless of temperature or load conditions; (4) eliminates smoke nuisance.

If you pay fuel bills for a factory, institution or building, let us show you what Iron Fireman can do for you. A letter to the company or to the nearest authorized Iron Fireman dealer will bring you complete information, including a survey of your own firing job, showing the savings and improvements you may expect. Models for commercial heating and power boilers up to 300 h. p. Quickly installed. Convenient time payment plan. Iron Fireman Manufacturing Company, Portland, Oregon; Cleveland, Ohio; Toronto, Can. Dealers everywhere.

●

Refer to Sweet's Engineering Catalog for detailed information about Iron Fireman automatic coal burners.

FOR CONTINUOUS HEAVY DUTY SERVICE IN POWER PLANTS UP TO 300 H. P.

IRON FIREMAN

AUTOMATIC *Self Regulating* COAL FIRING

IRON FIREMAN MANUFACTURING CO.
3063 W. 106th Street, Cleveland, Ohio

☐ Please make boiler room survey ☐ Send literature

Name.....

Company.....

Address.....

INDUSTRY DEMANDS *proved* PRODUCTS

FOR almost a century Powell Valves have been the choice of engineers. Because of the fundamentally correct design, workmanship, and materials, they meet the exacting demands of industry . . . withstand even abnormal working conditions. They are sturdy valves — built to last. The seats and discs can be renewed and the valves repacked under pressure without disconnecting them from the pipe line.

FIG. 1444
IRON BODY
O. S. Y.
GATE VALVE

GOOD VALVES SINCE 1846!

POWELL VALVE

It's a serious matter . . . costly and annoying . . . when a busy plant has to shut down for valve repairs. That's why it pays to use Powell service-proved products—valves that you can rely upon for dependable performance.

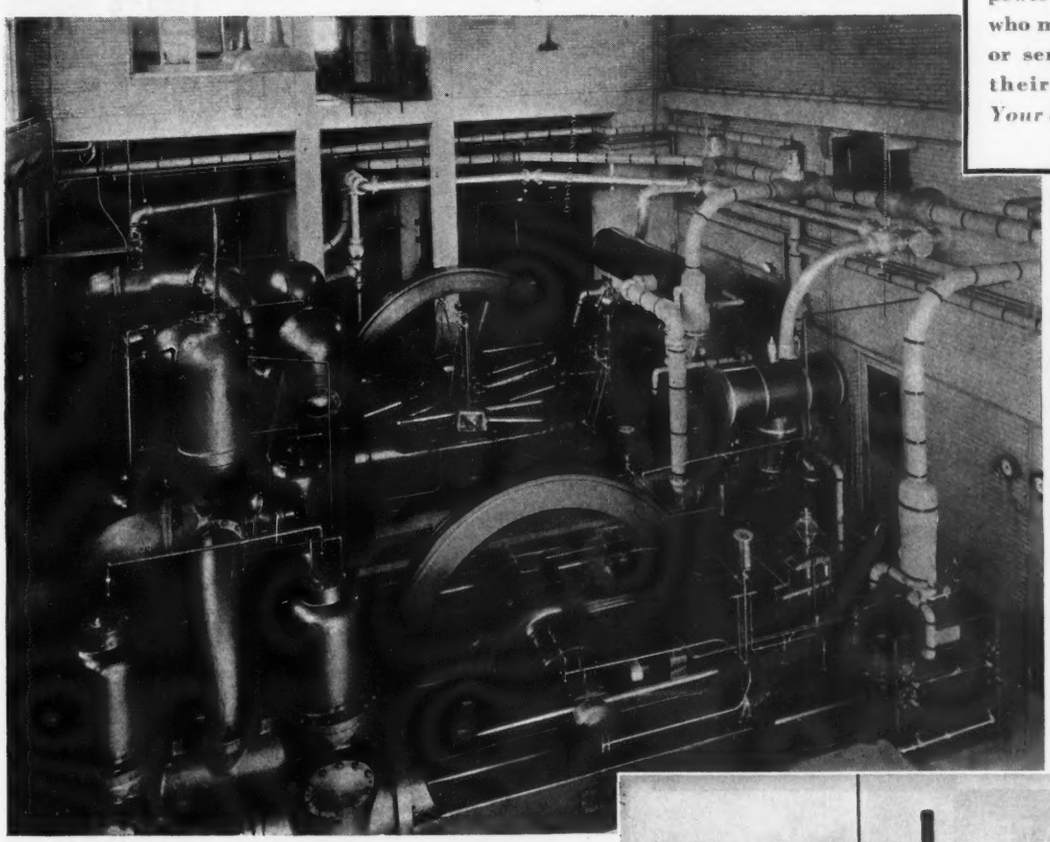
THE WM. POWELL COMPANY
2525 SPRING GROVE AVENUE, CINCINNATI, OHIO

POWELL VALVES

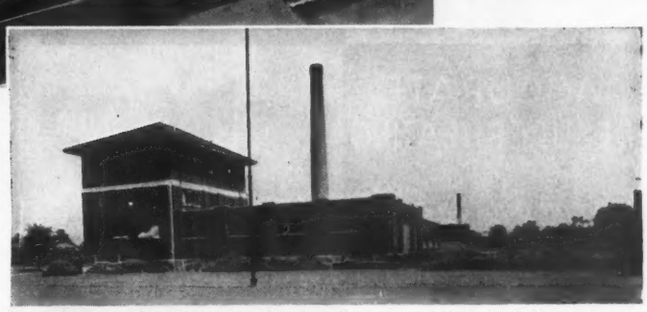
GULF HELPS YOU MAKE DEFINITE COST SAVINGS!

NOTE:

The booklet below will be sent to all industrial executives and power plant engineers who mail the coupon or send request on their letterheads. *Your copy is ready.*



Gulf lubricants keep this pumping equipment—in the City of Monroe, Mich. Water Dept. station—in continuous operation with low maintenance costs.



This plant supplies water for the city of Monroe, Mich., including a large number of well-known manufacturing plants.

Look to maintenance and power for your real lubrication costs!

Progressive power plant operators no longer consider the cost of lubricants alone as their *real* lubrication cost. They look to maintenance and power costs for a true index of their lubrication costs—and the influence of lubrication on operating expenses.

Gulf engineers work with power plant engineers to effect savings in operating costs by improved lubrication. Gulf's *complete* line of power plant lubricants permits the selection of exactly the right type of oils and greases to provide maximum protection for your equipment, under the operating conditions found in your plant.

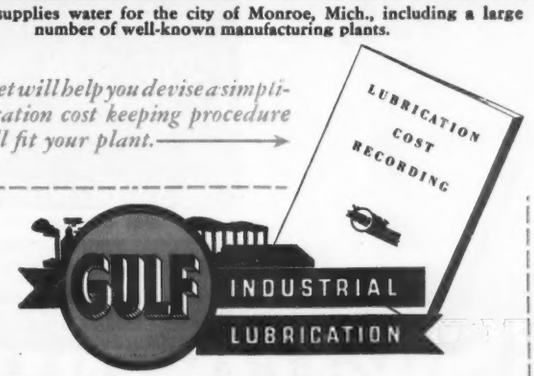
If you are not using Gulf products, we suggest that you discuss with a Gulf engineer just what savings may be effected through better lubrication in your plant.

GULF REFINING COMPANY, Pittsburgh, Pa.

District Sales Offices:

Boston New York Philadelphia Atlanta New Orleans
Houston Pittsburgh Louisville Toledo

This booklet will help you devise a simplified lubrication cost keeping procedure which will fit your plant. →

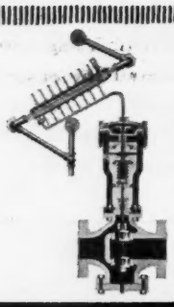


P. 12

GULF REFINING CO., 3800 Gulf Bldg., Pittsburgh, Pa.
Please send me without obligation, the booklet "Lubrication Cost Recording."

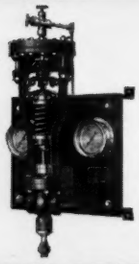
Name.....
Title.....
Company.....
Address.....

The Sure Way To REDUCED POWER COSTS



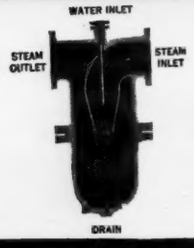
BETTER FEED WATER REGULATION
Send for Bulletin S-20-C

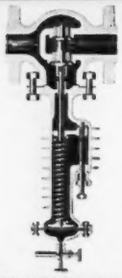
POSITIVE REGULATION OF EXCESS PRESSURES
Send for Bulletin S-19



MORE EXACTING PRESSURE REGULATION
Send for Bulletin S-23-A

ACCURATE DESUPERHEATING
Send for Bulletin S-21-C





EFFICIENT PUMP CONTROL
Send for Bulletin S-20-C

THE SWARTWOUT CO.
18501 EUCLID AVE.
CLEVELAND, OHIO

POWER PLANT EQUIPMENT
Swartwout
THE STANDARD OF QUALITY AND PERFORMANCE

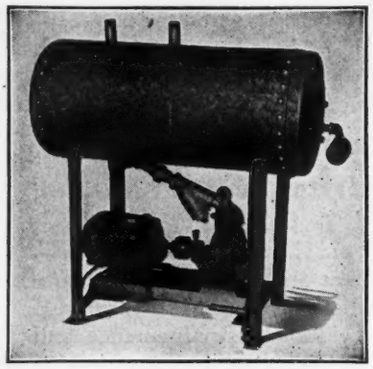
It Never Sleeps —Never Lapses

VIGILANT
Feed Water Regulator

CF

HUMAN attention and care in feeding a boiler cannot possibly approach the uniformity with which the **"Vigilant"** Feed Water Regulator will hold the water level once you have it properly installed. Perfectly automatic, simple, accessible, unfailing, the **Vigilant** eliminates a serious hazard, gives better steam production, and lowers fuel cost. Write for Bulletin 2514 which gives full information.

The CHAPLIN-FULTON MANUFACTURING CO.
28-40 Penn Ave. **Pittsburgh, Pa.**
Manufacturers also of the Fulton Pump Governor, Tank Governor, Reducing Valve, and other Fulton Steam Specialties.



The M-K-O Automatic BOILER FEED

Maintains a Constant Water Level in High or Low Pressure Boilers "Automatically"

All Feed Water worries are eliminated when the M-K-O Boiler Feed is used because it: Automatically pumps the feed water against high boiler pressure — Returns the condensate to the boiler —Supplies make-up water as required.
This Unit uses no steam. It can be used with Gas, Oil, Stoker or Hand-fired Boilers.

Ask for literature and prices.

NOTE: We also manufacture the well known Kane Fire-Tube Automatic Gas Steam Boiler and the Ofeldt Water Tube Gas-Fired Steam Boiler. Literature upon request.

MEARS-KANE-OFELDT INC.
Executive Office and Factory
1903-1915 EAST HAGERT ST., PHILADELPHIA
Branch Offices or Distributors in Principal Cities

J&L PIPE

WHEN PIPE MUST FIGHT

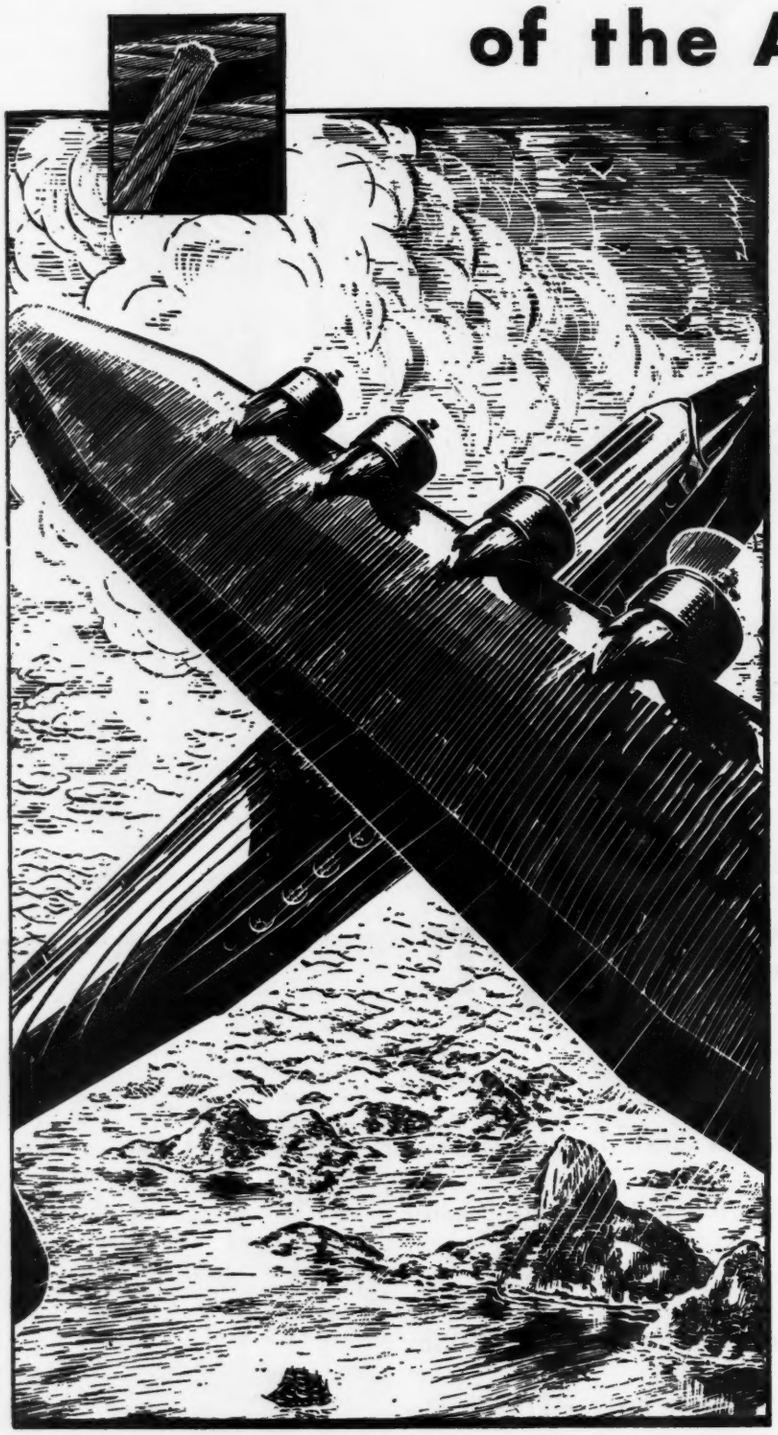
Pipe with dependable strength and "fighting" qualities is required in many applications if failure is to be avoided. In all such cases use Jones & Laughlin Seamless. It has full wall strength because there are no welds; it is exceptionally ductile, being made from selected steel of uniform quality. It is especially suitable for coiling and bending, and for use in air and gasoline lines, refineries, dry kilns, railroad signal systems and many other exacting applications.

USE
J&L
SEAMLESS
SIZES 1/2" TO 14" O.D.

J&L STEEL

JONES & LAUGHLIN STEEL CORPORATION
AMERICAN IRON AND STEEL WORKS
JONES & LAUGHLIN BUILDING, PITTSBURGH, PENNSYLVANIA

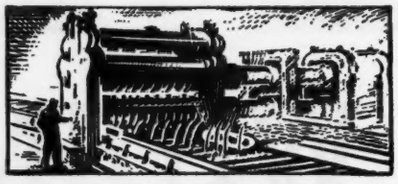
The Clipper King of the Air!



MUST HAVE CONTROL ROPE THAT IS UNFAILINGLY SAFE

Imagine a mammoth flying boat... carrying 32 passengers, a crew of six, over a ton of mail and express... and capable of flying 1250 miles without refueling. That's the "Brazilian Clipper"... holder of all ten world's records for transport seaplanes. It is one of three identical new Pan-American Airways' ships built by Sikorsky... the greatest of all trans-Atlantic type planes so far developed.

Designers selected Roebling Wire Rope for controls of all three ships. Almost a half mile of rope per ship.



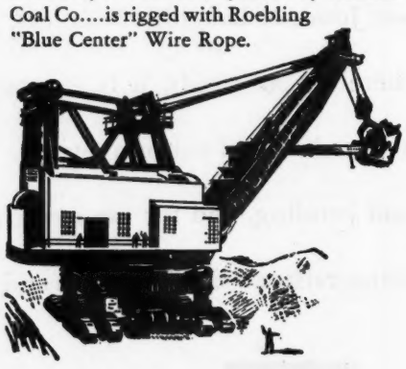
ROEBLING ROPE STEEL

It is acid open-hearth steel... made specifically for wire rope purposes... by Roebling's custom methods. Generally acknowledged to be the finest rope steel produced.

Roebling controls every process in making Roebling Wire Rope... from steel refining to finished product.

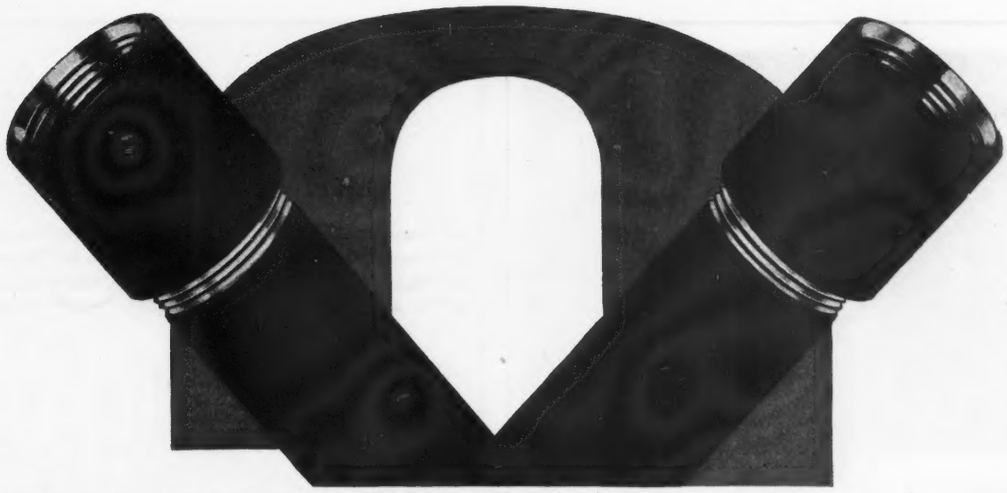
ONE OF THE WORLD'S LARGEST ELECTRIC SHOVELS...

an 18 cu. yd. "Marion", operated by Clemens Coal Co....is rigged with Roebling "Blue Center" Wire Rope.

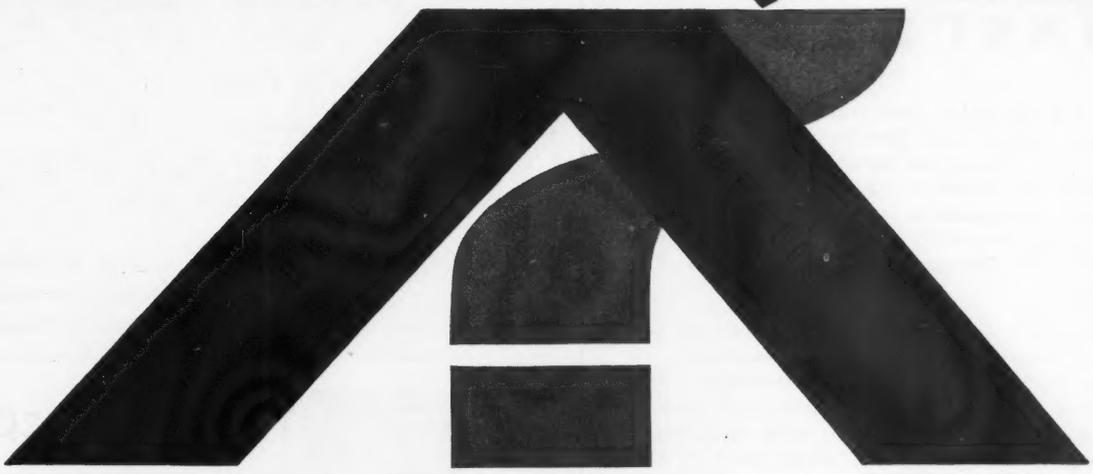


TO MAKE CERTAIN that Roebling Wire Rope will give the user the highest obtainable degree of safe, economical service, Roebling has enlisted the aid of the finest and most complete research, testing and manufacturing facilities. Roebling Equipment for making acid open-hearth steel is an example. John A. Roebling's Sons Company, Trenton, N. J. Branches in Principal Cities.

ROEBLING ...THE PACEMAKER IN WIRE ROPE DEVELOPMENT



THERE CAN BE NO QUESTION



TONCAN IRON PIPE DOES LAST LONGER

Records of the service given by Toncan Iron Pipe in every type of installation prove conclusively that this modern alloy pipe does last longer. This statement holds true whether it is used in a plumbing or heating system in a building, in process lines in industrial plants, for supply and drainage lines on board ship, or carrying acid mine water far underground.

In the latest edition of "Pipe for Permanence" you will find the records of many comparative tests. And you will also find the technical information that explains why Toncan Iron Pipe consistently renders better service than other ferrous pipe slightly lower in cost.

Toncan Iron Pipe is the only pipe obtainable today that takes advantage of the properties of refined iron, copper and molybdenum to form an alloy that is rust-resisting to a higher degree than any other ferrous material, except the stainless alloys. It is the only pipe that combines with this rust-resisting feature the many advantages that Republic's Electric Weld Process alone can claim—100% perfect weld, straightness, roundness, uniform wall thickness, freedom from inside defects and absence of scale inside and out.

Every pipe buyer should know the facts. A copy of "Pipe for Permanence" will be sent on request.

REG U.S. PAT. OFF.
TONCAN
COPPER
MO-LYB-DEN-UM
IRON PIPE

REPUBLIC STEEL CORPORATION

GENERAL OFFICES YOUNGSTOWN, OHIO

"MEGGER"

TRADE MARK REGISTERED U.S PAT OFF.

INSURANCE

IT IS a matter of plain truth that no electrical installation is better than its insulation. No matter how excellent a new motor or generator or how reputable the maker of the apparatus, if the condition of the insulation is permitted to fall below safe standards—which can be determined very easily by the "Megger" test—it is liable to cause trouble.

Failure of insulation can paralyze industry. Insulation weakness can be and is responsible for closing mills and factories—for throwing operations out of sequence—for wasting material—for causing workers to be idle—for tying up transportation—for endangering life. In all cases of electrical breakdown, money is lost.

For 25 years *"Megger" insurance*—which is simply the practice of making periodic "Megger" tests of insulation resistance of electrical equipment—has been applied with ever-increasing effectiveness to forestalling electrical breakdown, saving money and insuring efficiency.

Typical Examples—

With 9000 installed h.p. the Chief Engineer reports that they make periodic "Megger" tests on generators and motors, and have saved *"several thousand dollars."*
A Paper Mill in Wisconsin.

". . . have prevented serious damage and shutdown, and have saved a 250 kva. generator, a 40 h.p. motor and two 20 h.p. motors . . The 'Super-Meg' you supplied has proved its value many times."
A Food Products Plant in Indiana.

"We use your Megger on all the apparatus in the station every month—for I am a firm believer that prevention is better than cure."
Plant Engineer of a Hydro Electric Company.

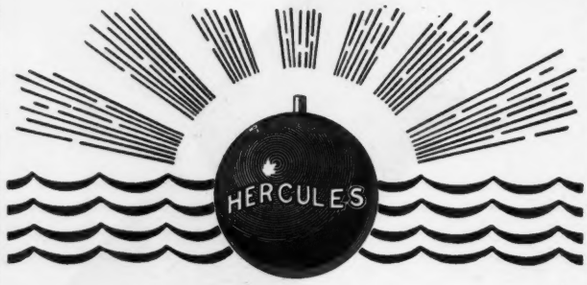
"The writer feels, personally, that money invested in a set of this kind pays more return on the principal than can be obtained from any other instrument of any character."
Chief Engineer of a Rubber Company in Ohio.

Please write for new Bulletin 1355-P describing the various types of "Megger" instruments.

JAMES G. BIDDLE CO.

ELECTRICAL INSTRUMENTS

1211-13 ARCH STREET PHILADELPHIA, PA.



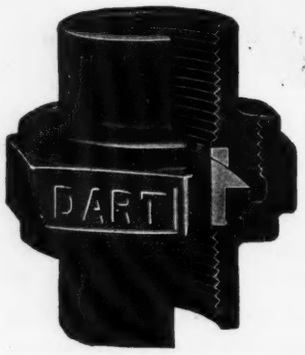
No Danger of Collapse . . . . . .

Not when HERCULES Seamless Copper Floats are used to maintain the water level in heaters, tanks, reservoirs and other appliances.

The special spinning process assures uniform thickness of metal and high mechanical strength. Every Hercules Float is guaranteed to stand up under 350 lb. working pressure and 500 deg. temperature.

Ready to ship — all standard ball shaped sizes to 10 in. inclusive. Special shapes or sizes furnished promptly on order.

HERCULES FLOAT WORKS
200 Franklin St., Springfield, Mass.



Bronze to bronze keeps them tight—

DART UNIONS

have bronze seats swedged into a groove and ground to ball and socket joint. These seats cannot work loose, cannot corrode.

Made in a complete line for every need. Try them out on the trouble spots—We'll be glad to send you A TRIAL UNION FREE.

E. M. DART MFG. CO.
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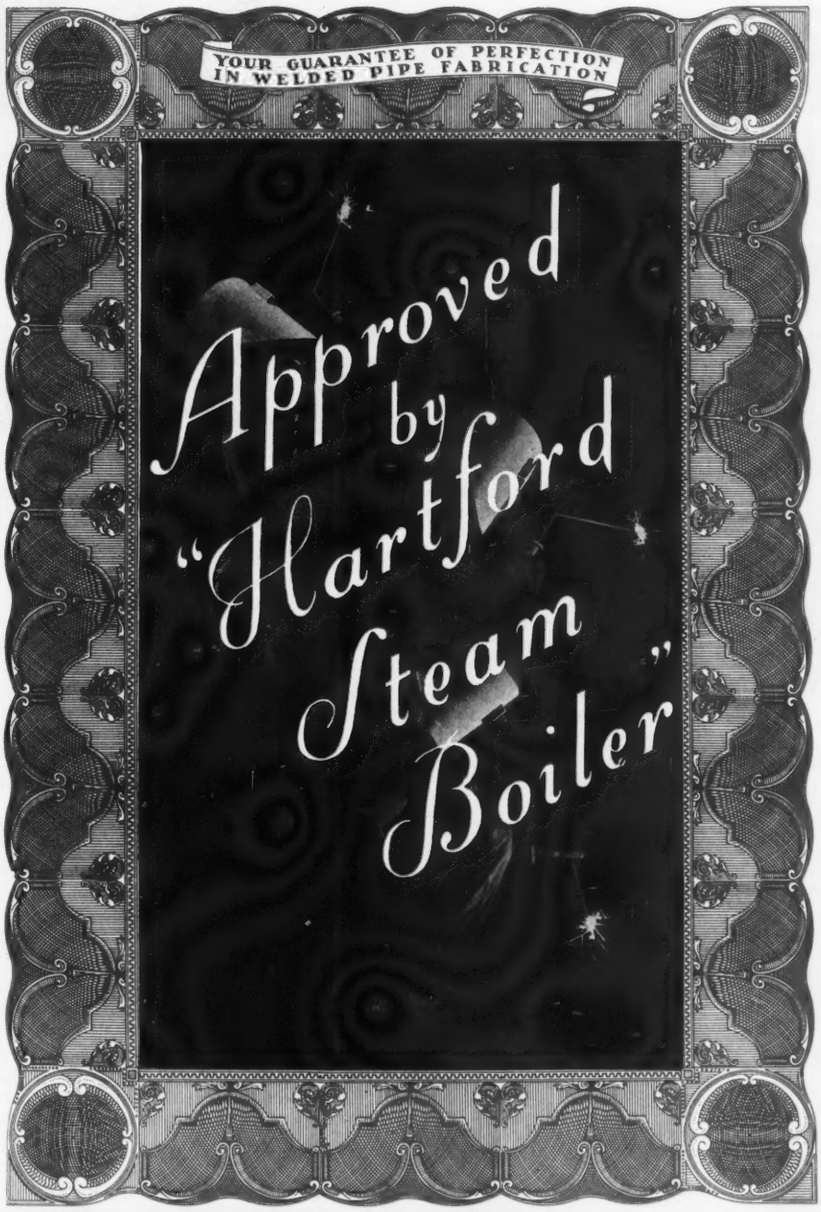


TRADEMARKed WELDING

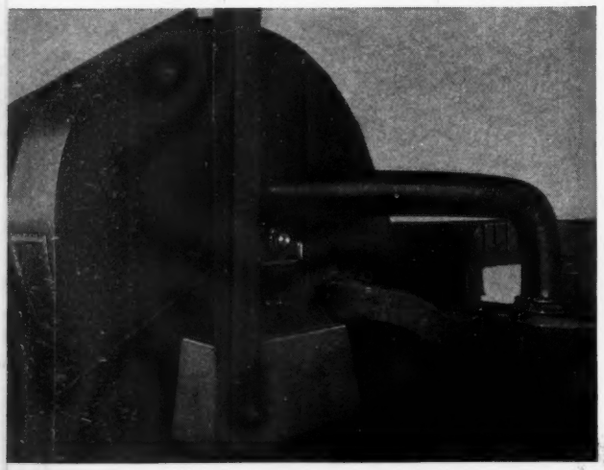
NO MATTER what article or service you buy, there are various degrees of quality which can be instantly recognized by the trademarks they bear. Each trademark is symbolic of a definite quality and protects the buyer against substitution of the inferior . . . "Approved by Hartford Steam Boiler" is like a trademark, for it too represents a definite quality in welded pipe fabrication which is acceptable to them for insurance. Their approval of our methods embraces electric arc and oxy-acetylene up to 1⅛" wall thickness in any position, thus on any welding job in pipe fabrication, you know the work is being done by men of proven ability to produce quality welds. . . . Even with this unquestioned, demonstrated skill, we prefer to make as many welds as possible in our own shops, where our experts have the benefit of modern, adequate shop facilities. . . . Write for the "Book of Installations" of the Benjamin F. Shaw Co., Wilmington, Del.

SHAWCO

POWER & INDUSTRIAL PIPING FABRICATORS & CONTRACTORS

THESE LITTLE PIGS

WITH A SAVING



GURE 1—*Forward Curved Sirocco Induced Draft Fans with Sirocco Spiral Inlet Collectors (on the right) in the main plant of Wilson & Co., Chicago, Ill.*

GURE 2—*(below) Hydraulic Couplings which are used on the Forced and Induced Draft Fans and also on a 100 horsepower ammonia compressor.*

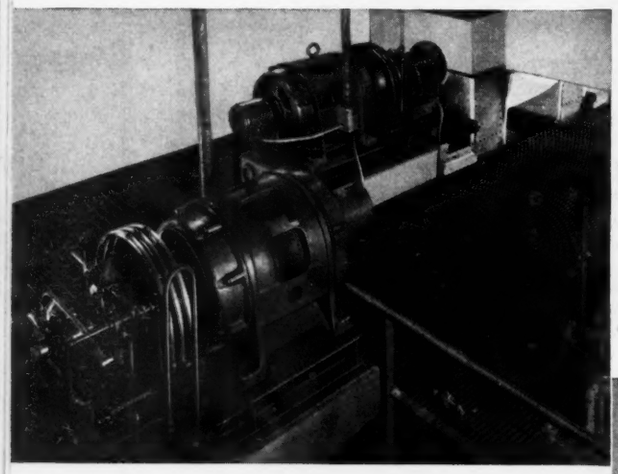
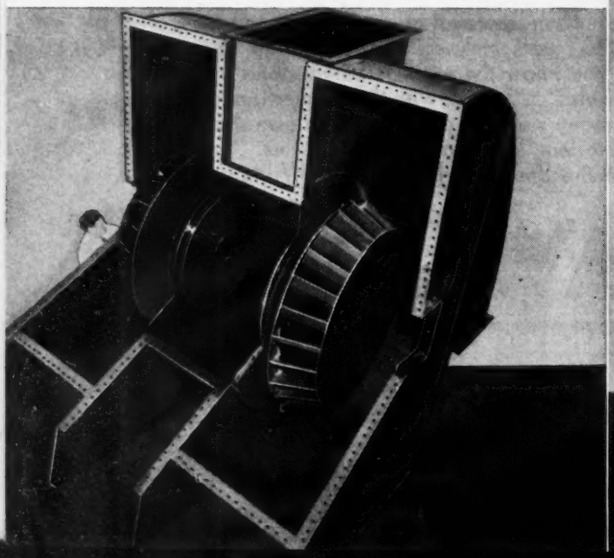


FIGURE 3—*(below) Showing the Inlet Vanes of the Sirocco Spiral Inlet Collector used on the Wilson & Co. plant.*



ALMOST as old as the Mother Goose rhymes is the packing industry's reputation for low distribution, sales and marketing costs. So unbelievably small is the packers' percentage of the dollars spent for meat that no one outside the industry, and comparatively few packers themselves, had figured further savings possible.

Yet competent, capable engineers, Allen McKenzie, J. M. Lenone and P. L. McGehee of Wilson & Company, with a background of years of experience, visioned even greater efficiency for the industry that has always been known as one of America's most efficient.

Well they knew the small percentage of the dollar the packer works on and they were thoroughly familiar with the parts of pennies per pound spent for power. Yet they made their attack in the power plant, figuring that what was economical and efficient operation over a period of years might possibly offer a means of further economy and further efficiency under present operating conditions with modern machinery and equipment.

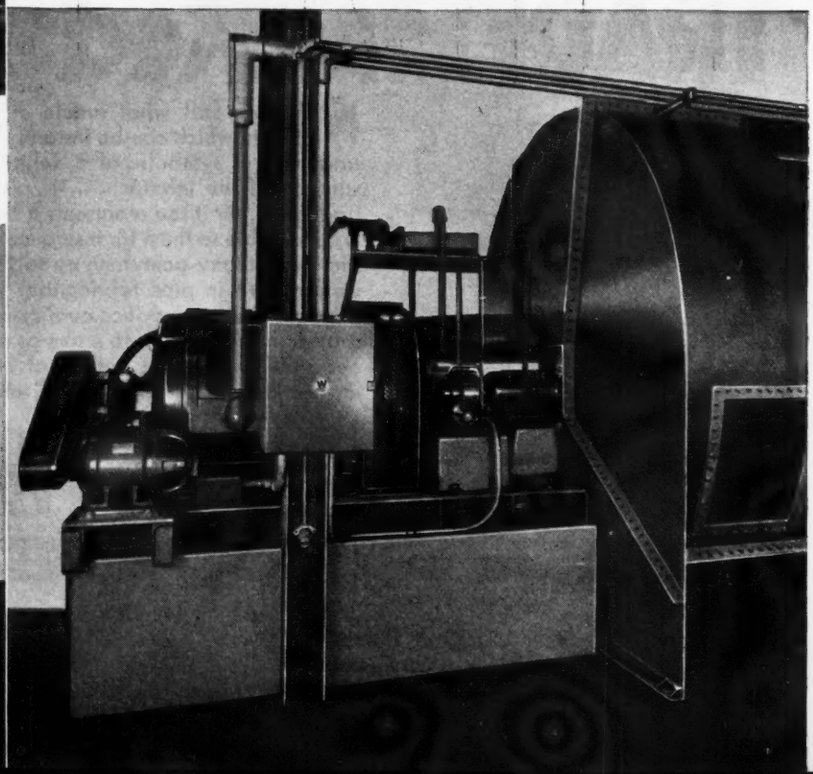
The result of their work is the new, complete, compact power plant of Wilson & Company, Chicago. This plant not alone typifies all that is modern in engineering methods and procedure, but is one that, conservatively estimated, is capable of saving upwards of $100,000 annually.

Approximately 18,000 tons of coal will be saved yearly, although the same amount of process steam as was formerly used will be generated, as well as all electrical energy. Processing and manufacturing departments have been speeded up. More power than needed for 100% increased operation can be made.

There is no shoveling of coal nor raking out of ashes. Conspicuous by their absence are numerous workers watching steam and water gauges; tall stacks belching smoke; the dirt and grime of ordinary power plants.

Entirely new in American power plant procedure is the combination of Spiral Inlet Collectors, Forward Curved Fans, Hydraulic Couplings and synchronous motor drive. Many power plants had used one or more of these appliances but Messrs.

FIGURE 4—*(below) Close up view of the completed installation of the Sirocco Forward Curved Induced Draft Fan and the Hydraulic Coupling, (left) in the Wilson & Co. plant.*



Went to Market

OF $100,000 YEARLY

McKenzie, Lenone and McGehee in their scheme of things selected all four to make the packers' exceedingly small part of the dollar go farther.

The Hydraulic Coupling (see figures 2 and 4) is a simple, efficient means of driving a machine at an infinite number of speeds with a constant speed driver. Its characteristics are such that it is particularly adaptable to machines whose power varies as to the cube of the speed, such as pumps or induced and forced draft fans similar to the ones used in the Wilson & Company plant. The Hydraulic Coupling makes it possible to combine the electrical advantages of constant speed induction or synchronous motor drive with the numerous operating advantages of variable speed drive.

The application of the Hydraulic Coupling in the Wilson & Company plant eliminates damper controls and electric motor control equipment and makes possible a minute automatic adjustment of speed. It also greatly reduces erosion and effects power savings of substantial size. (See figures 2 and 4.)

The Sirocco Spiral Inlet Collectors (see figures 1, 3, and 5) have a distinct and decided advantage and are fittingly placed in this model power plant to minimize the fly ash nuisance and further to prevent erosion. Their ability to perform effectively in small space with a minimum of care and attention over a long period of years means a saving of valuable space and long life to complementary equipment.

Forward Curved Sirocco Induced Draft Fans further add to the efficiency factor of this plant. The Sirocco fan wheel inherently affords more sensitive response to speed changes than other types and the low tip speed characteristic of the Sirocco Fan insures long life and further minimizes erosion and the results of erosion. The Sirocco Fan operates at the lowest tip speed of any fan on the market. High Speed Fans, Hydraulic Couplings and synchronous motors furnish air for forced draft.

The maximum advantages of power factor correction through synchronous motors on both forced draft fans and induced draft fans is permitted by the use of Hydraulic Couplings. The advantages and economies of the one are made possible by the use of the other, all to the benefit and profit of the packers' small part of the dollar.

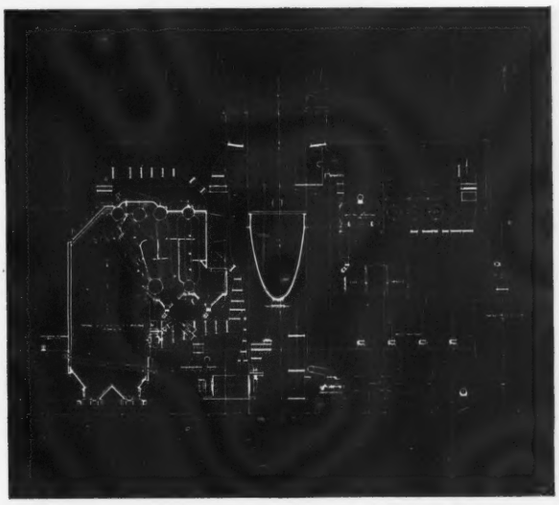
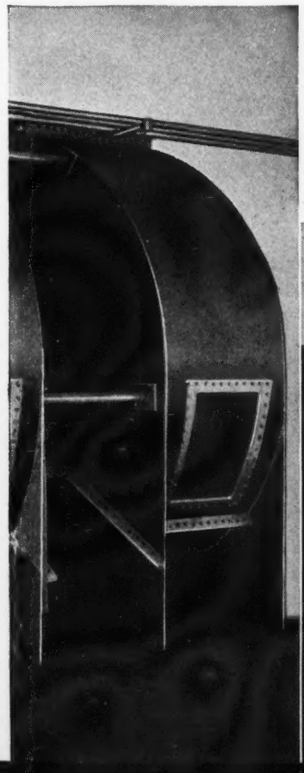


FIGURE 6—*(at right) Longitudinal section of Wilson & Co.'s new boiler room.*

Hydraulic Couplings are also used in the Wilson & Company power plant for furnishing variable speed drive to a 100 h. p. ammonia compressor.

Much has been said of the capabilities of the men and equipment responsible for this new power plant—much more will be said of the efficiency and skill of the packing industry as exemplified by Wilson & Company. But perhaps you have a similar opportunity to profit—to stretch your part of a dollar.

The American Blower Corporation, with more than 50 years' experience in air handling—air conditioning, mechanical draft, dust collection, heating, ventilating, air washing and cooling equipment—is always ready to consult with interested engineers with regard to increasing plant efficiency and economy or improving operating conditions. There is no obligation. American Blower offices in charge of competent engineers are located in all principal cities.



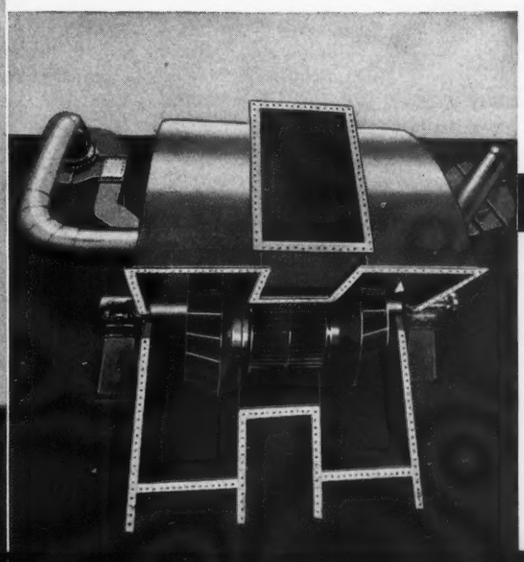


FIGURE 5—*(below) Bird's-eye view of the Sirocco Forward Curved Induced Draft Fan coupled with the Sirocco Spiral Inlet Collector (Showing collectors in background, also see FIGURE 3)*

AMERICAN BLOWER CORP.

DETROIT, MICHIGAN

CANADIAN SIROCCO CO., LIMITED, WINDSOR, ONTARIO

BRANCH OFFICES IN ALL PRINCIPAL CITIES

Division of American Radiator and Standard Sanitary Corporation

COUPON

AMERICAN BLOWER CORPORATION
6000 Russell Street, Detroit, Michigan

I am interested in plant improvement and economy.

Send data on Air Conditioning ☐

Sirocco Forward Curved Induced Draft Fans ☐

Sirocco High Speed Fans ☐ Sirocco Spiral Inlet Collectors ☐

*Name*_____

*Firm Name*_____

*Street Address*_____

*City and State*_____ (1318)

For Greater Flexibility
USE SUPERFLEXIBLE CORRUGATED *Tangents with* CREASED *Bends*

The trend in central stations, industrial and marine power plants toward higher temperatures—higher pressures—minimum space—requires advanced piping design.

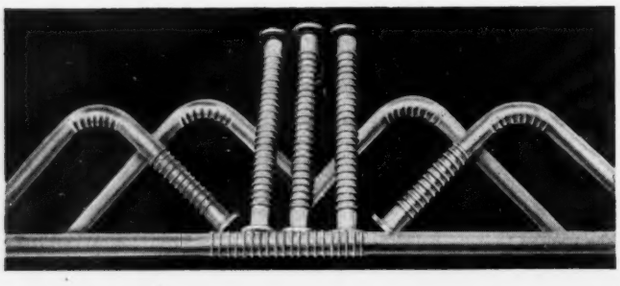
Pittsburgh Piping & Equipment Company meets these conditions by announcing the manufacture of Superflexible Corrugated Tangents in connection with their well-known and widely used Creased Bends.

The use of Pittsburgh Piping's Creased Bends with Superflexible Corrugated Tangents permits piping layouts confined to close quarters, yet avoids excessive bending moments and anchor reactions.

Elimination of all welded joints results in higher allowable stress.

For a simplified method of obtaining bending moments and anchor results in piping systems employing these superflexible members and for their correct application and advantages—

WRITE FOR BULLETIN.



Photograph shows 6" x .288" Superflexible Corrugated Tangents, Creased Bends and Creased Bends with corrugated tangents.

PITTSBURGH PIPING AND EQUIPMENT CO.

43RD ST. & A.V.R.R. PITTSBURGH, PA.

P P & E Co.

BRANCH OFFICES

Indianapolis — New York
San Francisco — Chicago
Cleveland — Detroit
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A man with a trowel and EAGLE "66"

STOPS HEAT WASTE

Here is why you will profit from using EAGLE "66" PLASTIC INSULATION:

First—You want insulating efficiency, and Eagle "66" is extremely efficient up to 1800° F.

Second—It goes on quickly and easily. A man with a trowel and Eagle "66" does the job in a hurry. No special tools needed. This plastic insulation goes on easily around corners and over irregular surfaces.

Third—Eagle "66" Plastic Insulation sticks to hot surfaces like glue, forming a strong, efficient one-piece insulation. No joints or seams to open up and let out the heat.

Fourth—Eagle "66" is 100% reclaimable. Alterations, changes, repairs are easy and inexpensive to make.

Fifth—Eagle "66" has 25% to 75% greater coverage than other plastic insulating materials—50 square feet 1" thick per 100 lb.

• Before you do another insulating job, get a free sample and all the facts about Eagle "66" Plastic Insulation. The coupon is for your convenience.

THE EAGLE-PICHER LEAD COMPANY

Manufacturers of a full line of industrial insulating materials for a complete range of temperatures. Branch Offices and Stocks in Principal Cities.

• The Eagle-Picher Lead Company, Dept. P-12, Cincinnati, Ohio.
Please send free sample and descriptive catalog of Eagle "66" Plastic Insulation.

Name _____

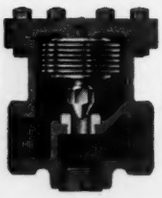
Address _____

City _____ *State* _____

NICHOLSON STEAM TRAPS

FOR ALL PRESSURES

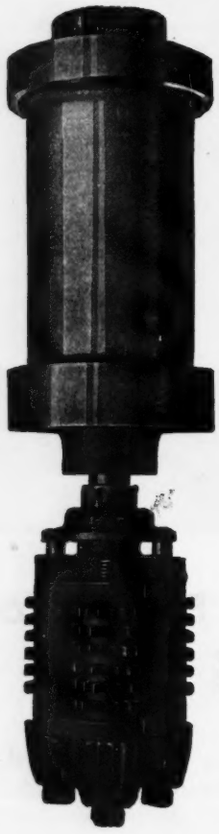
Piston Operated	—	0 to 600 lbs.
Weight Operated	—	0 to 450 lbs.
Expansion Type	—	0 to 200 lbs.
Bellows Type	—	0 to 200 lbs.



Industrial Trap
Bellows type

TRAPS for any service from draining a steam heated glue pot to a large steam separator or purifier. Combination Steam Separators and Traps. Also 2, 3 and 4-way Valves for single or double acting cylinders, in Lever, Foot, Solenoid or Motor Operated types on air, oil, water or steam service. Ball Floats of steel or Stainless Steel. Air Separators and Moisture Traps. Write for Bulletins.

W. H. NICHOLSON & COMPANY, 125 Oregon Street, Wilkes-Barre, Pa.



Roto Heavy Duty Type for 3½-4" Straight Tubes Featuring the Roto Swing Frame Head.

DEPENDABILITY in tube cleaners....will be found in the ROTO

Because the best materials and the highest grade of workmanship are used in their construction, and their reputation is backed by an extremely large number of satisfied customers.

Regardless of your conditions there is a Roto Tube Cleaner that will satisfactorily remove the scale as we manufacture a complete line of mechanical cleaners for all tubular equipment, which is described in our catalog, a copy of which will be sent you upon request.

THE ROTO COMPANY

SUSSEX AVE. AND NEWARK ST., NEWARK, N. J.

FRANCE

Metallic Packings of the better class

Ideal for superheated or saturated steam, ammonia, air or gas, for all pressures and operating conditions. Last 5 to 25 years. Sold on approval.

Write for catalog and list of users.

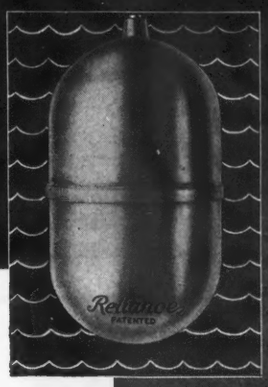
FRANCE PACKING COMPANY

6600 Tacony St., Philadelphia, Penna.

STRAW MAN*

* "A FICTITIOUS ANTAGONIST, OR A FALSE ASSUMPTION"

—Funk and Wagnalls
Unabridged Dictionary



We submit the following facts to those Engineers who recognize the importance of protecting their boilers with dependable water level alarms:

Reliance Floats are Unsinkable in Service.

—Made that way and proved—of fused Monel Metal, internally re-inforced, tested at twice working pressures.

—More than 25,000 gone into service over past 5 years—and we simply have no replacement business on these monel floats.

Reliance Monel and Stainless Steel Floats are GUARANTEED.

—They won't leak or collapse in service at pressures sold for—a fact as well as a promise, backed by free replacement.

Reliance Float-Actuated Alarms are more than 4 times as quick-operating as any other type of water alarm.

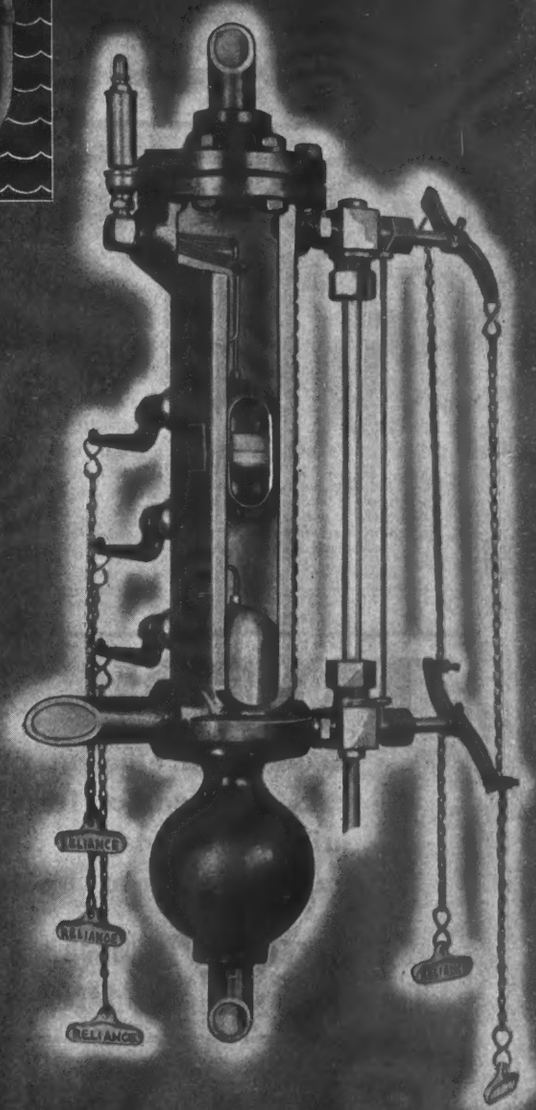
—Tests to prove it. Only buoyant alert float can give instantaneous action.

Reliance Columns Work Every Time.

—Over 125,000 in service during 50 years.

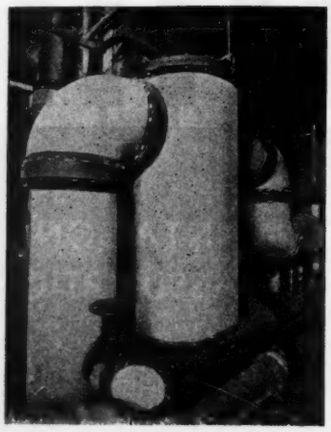
—Not one known failure in an emergency.

THE RELIANCE GAUGE COLUMN CO.
5902 CARNEGIE AVE., CLEVELAND, OHIO



Reliance
SAFETY WATER COLUMNS

FOR REALLY HAIR-TRIGGER DEPENDABLE CONTROL OF BOILER WATER LEVELS, SPECIFY RELIANCE



A 20″ Horizontal Oil Separator. Large oil separators, between reciprocating engines and turbines, will remove both oil and water from steam before it reaches the turbines, increasing efficiency and preventing clogging and cutting out of blades.

DRY STEAM

Less than ½ of 1% of water guaranteed

CLEAN STEAM

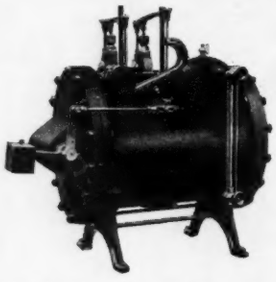
Less than 1/3 grain of oil per gal. of condensate

Remove the water and save fuel and repairs. Remove the oil and do away with troubles caused by oil in boilers. Insure clean, dry steam for reciprocating engines, turbines, turbine driven pumps and other equipment, with Direct Separators. Every installation guaranteed to deliver 99.5% dry steam, or better—to clean exhaust so thoroughly that less than 1/3 grain of oil will be contained in each gallon of condensate. Many standard types—special designs for special conditons. Write for catalog and specific information.

THE DIRECT SEPARATOR COMPANY
INCORPORATED
SYRACUSE, N. Y.

WE MAKE AIR-SEPARATORS AND EXPANSION JOINTS IN ALL STYLES AND SIZES

DIRECT SEPARATORS



The Sterling Boiler Feed or Lifting Pump is ruggedly constructed and will stand up and deliver dependable service with very little maintenance attention.

Sterling BOILER FEED SYSTEMS

pay for themselves in a reasonable time

The Sterling System prevents heat losses by returning high and low pressure condensate directly to the boilers. It is simple, positive, and dependable in action. Power operators report that their cost records show the Sterling System pays for itself within a year through fuel savings. Please accompany your request for layout with memorandum of your problem.

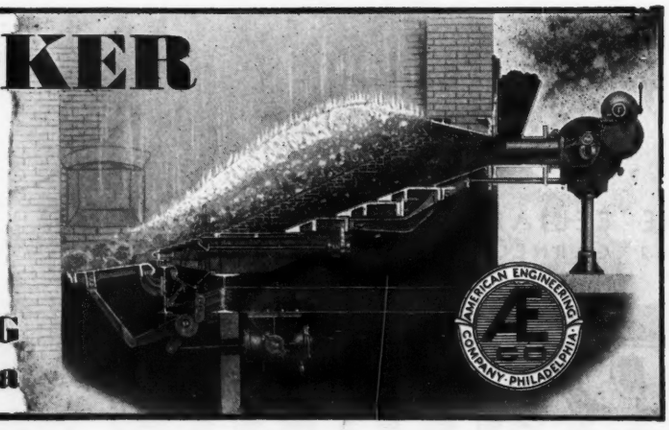
STERLING ENGINEERING & MFG. CORPORATION
HYDE PARK ═══ **BOSTON, MASS.**

Energetic Sales Engineers needed in certain cities.

TAYLOR STOKER

Economical, efficient. Burns coal as it comes from the mine. Obtains maximum capacity from boilers.

AMERICAN ENGINEERING Company Philadelphia



Uncle Sam Knows His "Three's"

Army, Navy and Marines. Each has covered itself with glory. Each *belongs* in the national defense scheme; we can't do with one or two, we need all three.

Do You?

Many other important things come in related three's —lubricants, for example.

To give you full money's worth, your oils and greases must contain three essentials. First is suitable Crude; no unsuitable Crude makes a satisfactory lubricant. Second is Refining; it must preserve and develop the quality of the Crude. Third is Application; no good lubricant performs rightly if Applied wrongly. Do you get all three now?

These three are present in Pure Oil's "Three-Point Lubrication Service". For lowest cost and best performance, let a Pure Oil man demonstrate "Three-Point Service" to you.

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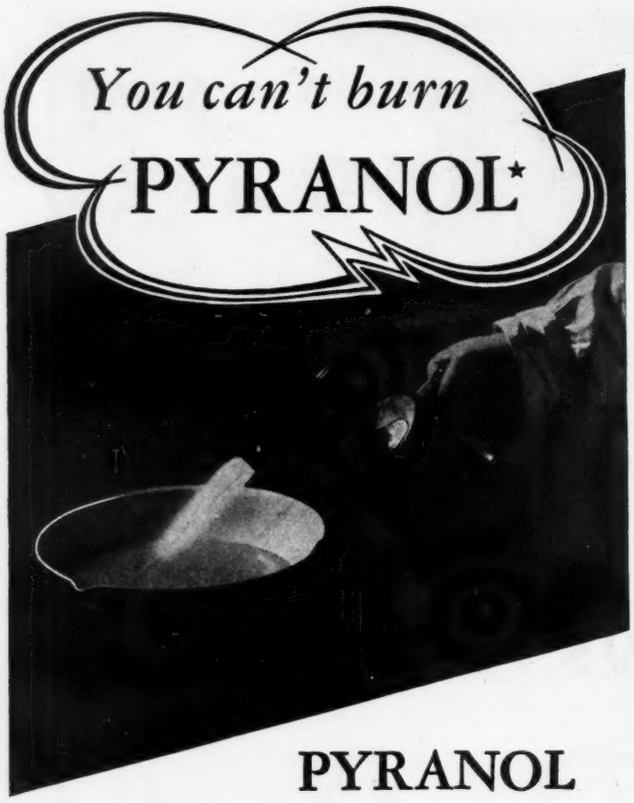

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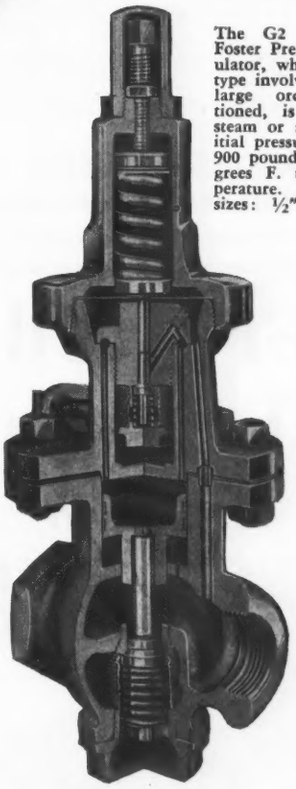

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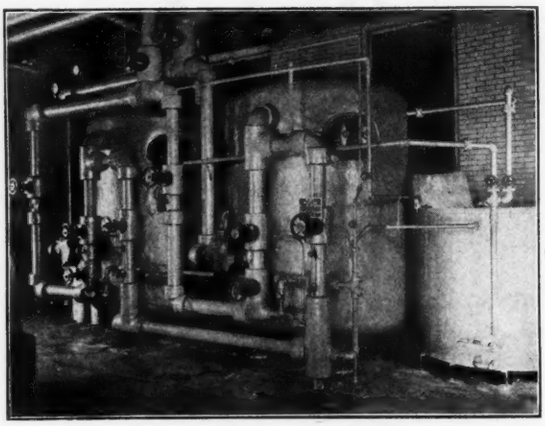

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As PYREX Gauge Glasses are the product of scientific methods and rigidly standardized processes it is possible to publish safe working pressures to apply to any melt and production run of PYREX Gauge Glasses. Glasses do not vary from melt to melt.

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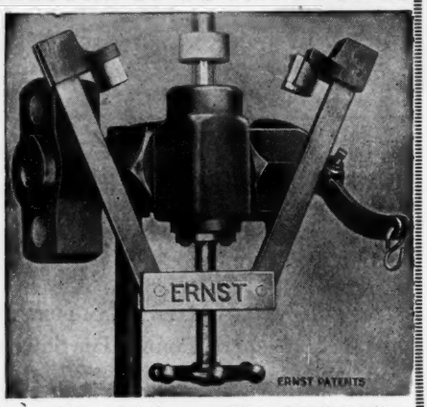

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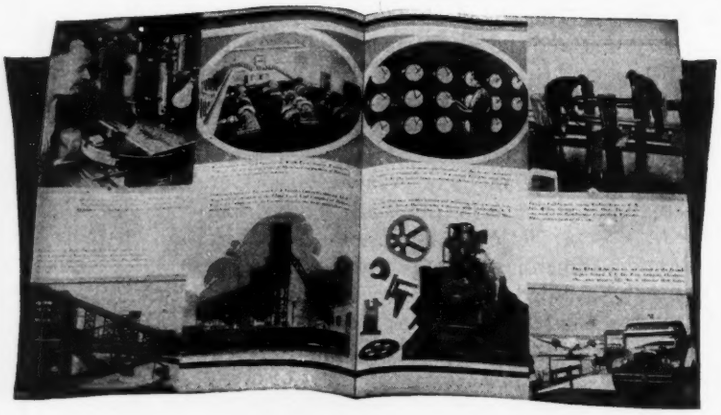

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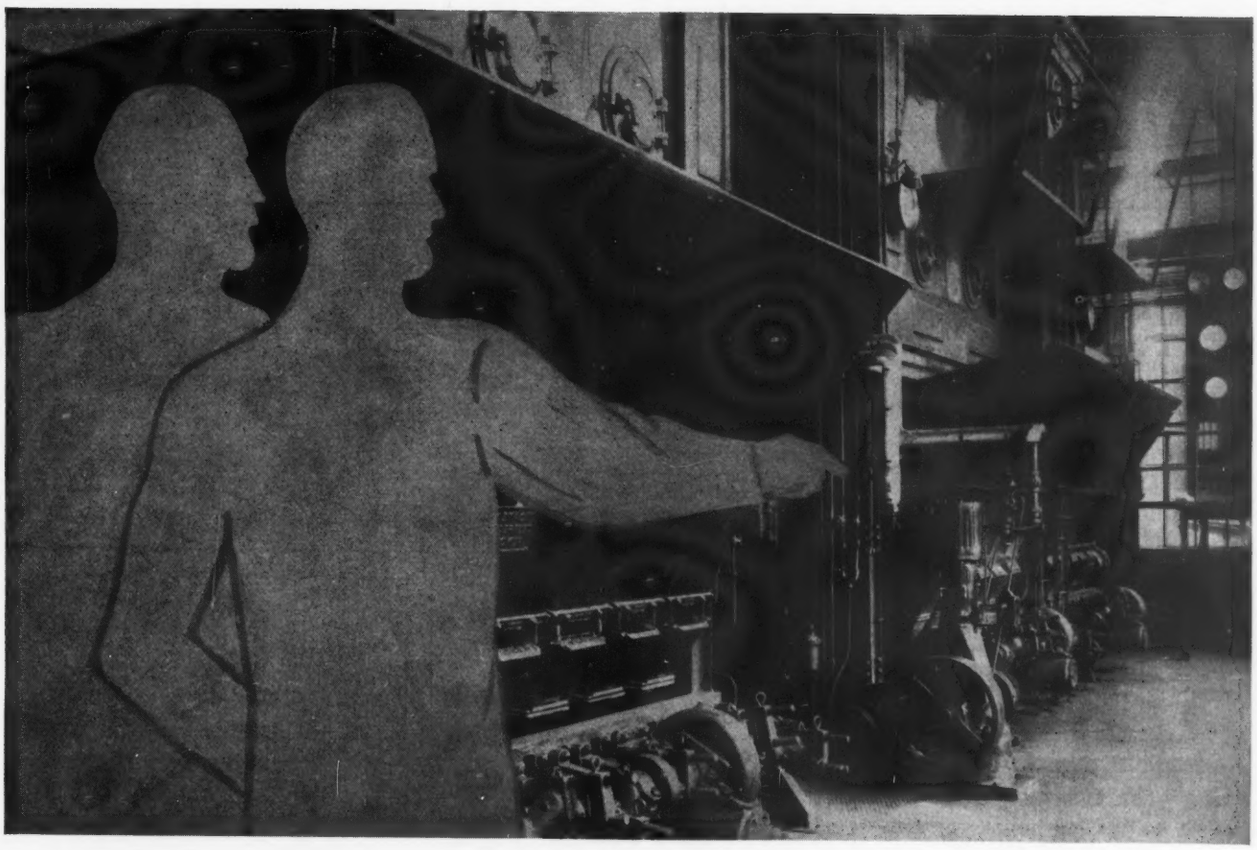

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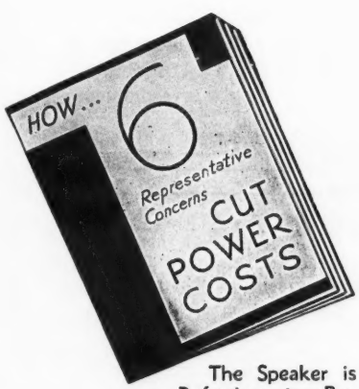

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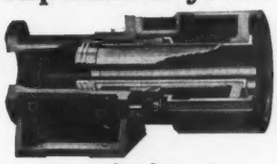

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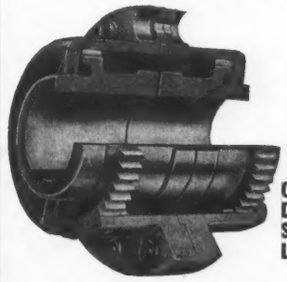

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INFORMATION:

Box Numbers **in care of our New York, Chicago and San Francisco offices count 10 words additional in undisplayed ads.**

Discount **of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).**

DISPLAYED—RATE PER INCH:

1 inch $6.00
2 to 3 inches..... 5.75 an inch
4 to 7 inches..... 5.50 an inch

Other spaces and contract rates on request.

An advertising inch **is measured vertically on one column, 3 columns—30 inches—to a page.** **P.**

Copy received by the 25th of a month effective with following months issue.

EMPLOYMENT SERVICE

SALARIED POSITIONS, $2,500 to $25,000. This thoroughly organized advertising service of 25 years' recognized standing and reputation carries on preliminary negotiations for positions of the caliber indicated, through a procedure individualized to each client's personal requirements. Several weeks are required to negotiate and each individual must finance the moderate cost of his own campaign. Retaining fee protected by a refund provision as stipulated in our agreement. Identity is covered and, if employed, present position protected. If you have actually earned over $2,500, send only name and address for details. R. W. Bixby, Inc., 270 Delward Bldg., Buffalo, N. Y. (P.)

POSITION WANTED

I.C.S. STUDENT power house electric course nearly complete. 3 years' experience 2,000 hp. pumping plant. Desires change, small or medium hydro electric. Now employed. PW-376, Power, 883 Mission St., San Francisco, Calif.

REPRESENTATIVE AVAILABLE

Western Mo. & Eastern Kan.
Established Organization would like additional lines of equipment. RA-394, Power, 520 North Michigan Ave., Chicago, Ill.

OFFICIAL PROPOSAL

Bids: December 28.

Power Plant Equipment

Pullman, Washington.

Sealed proposals will be received by the Board of Regents of the State College of Washington, E. O. Holland, Secretary, at the Davenport Hotel, Spokane, Washington, Friday, December 28, 1934, at 1:30 P.M. for the furnishing and installing of certain mechanical equipment for the Power Plant now under construction on the campus of the State College of Washington, Pullman, Washington. This work will be done under the provisions of the Federal Public Works Administration and the State Emergency Relief Administration. This improvement shall be constructed under the contract provisions of Bulletin No. 2, PWA "Requirements as to Bids, Contractors' Bonds, and Contract, Wage, and Labor Provisions" dated March 3, 1934. "No Bid will be considered unless accompanied by the bidder's Certificate of Compliance, U. S. Government Form P.W.A. 61, revised March, 1934, to the effect that the bidder is complying with and will continue to comply with each applicable code of fair competition, or in the absence of such code or codes, with the President's Reemployment Agreement. Copies of this certificate will be included with the 'Instructions to Bidders.' " Attention is called to the fact that not less than the minimum wage rates prescribed by the Federal Emergency Administration of Public Works must be paid on this project. Labor required for this improvement shall be chosen from lists submitted by the United States Employment Service (National Reemployment Service) or as provided in paragraph "3", section "b" of the contract provisions. Whitman County office of the National Reemployment Service is in the charge of Mr. R. W. Brown, Postoffice Building, Colfax, Washington. Bids shall be accompanied by a certified check made payable to the Board of Regents of the State College of Washington for five per cent (5%) of the bid (including alternates.) Should the successful bidder fail to enter into the contract and furnish a satisfactory performance bond in the full amount of the contract price within the time stated in his proposal, this certified check shall be forfeited to the Board of Regents of the State College of Washington as liquidated damages. The checks of the unsuccessful bidders will be returned to them within ten days. The Board reserves the right to reject any or all bids. The successful bidder will be required to file a performance bond in the full amount of the contract price, which bond shall be furnished by a surety company acceptable to the Public Works Administration and to the Owner. Bids will be called for on the following divisions of the mechanical equipment:

SPECIFICATION NO. 1: "New Steam Generating Units," Boiler Units Nos. 1 and 2. Deposit for set of plans and specifications, $15.00. Specification No. 1 includes one complete 500 h.p. boiler unit of the straight water tube type together with water-cooled furnace, under-feed stoker, and instrument panel. Boiler Unit No. 2, economizers, chain grate stokers, are alternatives to Specification No. 1.

SPECIFICATION NO. 3: "Coal and Ash Handling Equipment"—Deposit, $10.00—Includes a complete coal and ash handling system, with apron, pivoted bucket and screw conveyors, an overhead coal and ash storage bin, an ash car and track system and miscellaneous hoppers and spouts.

SPECIFICATION NO. 4: "Power Plant Piping, Subway Piping"—Deposit, $15.00—Includes all piping, valves and fittings for the Power Plant, and a subway tunnel, together with insulation and supports.

SPECIFICATION NO. 5: "Fans, Ducts and Breeching"—Deposit, $5.00—Includes one forced draft fan and two induced draft fans with steam engine drives, together with a complete duct and breeching system.

SPECIFICATION NO. 6: "Feedwater Treating Equipment and Boiler Feed Pumps"—Deposit, $5.00—Includes deaerator-heater, hot well, boiler feed pumps, condensate pump, and the hot process softening equipment, using lime, gypsum, and sodium phosphate, together with necessary piping, valves, fittings, insulation and structural supports.

SPECIFICATION NO. 7: "Electrical System"—Deposit, $5.00—Includes a rigid iron conduit and wiring system for light, power, and telephones.

SPECIFICATION NO. 8: "Motors and Transformers"—Deposit, $2.50 — Includes electric motors and transformers, f.o.b. Cars at Pullman.

SPECIFICATION NO. 9: — Deposit $50.00—Includes a full set of the above plans and specifications (except Specification No. 8). This provides for a lump sum bid for all of the work under Specifications Nos. 1, 3, 4, 5, 6 and 7.

Plans and Specifications are on file at the Builders' Exchange in Seattle, and the Associated General Contractors, in Spokane, and McGraw-Hill Publishing Co., Inc., 330 West 42nd St., New York, N. Y. Additional plans and Specifications may be obtained from H. H. Langdon, Engineer, State College of Washington, Pullman, Washington, by depositing a check for the amount stated, which deposit will be returned upon receipt of the same in good order and within one month after the Contracts are let. No plans and specifications will be sent out after December 21, 1934. This advertisement was first published December 3, 1934.

E. O. HOLLAND,
Secretary.

OFFICIAL PROPOSAL

WANTED
Manufacturers' Agents
or Distributors for complete line of refractories including plastic fire brick, super refractory cement and special refractories. Proven by more than 10 years satisfactory performance. Men experienced with boiler and furnace equipment or allied products preferred. Write for special proposition now being offered for new territory.
INLAND FIRE BRICK COMPANY
1552 West 25th Street, Cleveland, Ohio

SALES REPRESENTATIVES WANTED
By Large Manufacturer of
REFRACTORIES

On high-grade account of plastic fire brick and high temperature cement in Northern Ohio, California, Philadelphia, Texas and Oklahoma territories. Some knowledge of refractories and application in different types of furnaces advisable. This account fits in well with other lines of power plant equipment. No replies considered unless complete history of past sales experience is given. Commission basis. If past sales record warrants, drawing account may be arranged.

RW-396, Power
520 No. Michigan Ave., Chicago, Illinois

WANTED

WANTED
AIR COMPRESSOR
1—Used steam driven, 7x7x7, to operate on 100 lb. to 110 lb. steam pressure. Give full details. Write
Baxter Laundries Corporation
747 Fountain St., Grand Rapids, Mich.

BUYER OF SURPLUS AND SALVAGE STOCKS
Metals, Chemicals, Raw Materials, Fabrics, Manufactured Products; Entire Plants, including Machinery, Tools, Equipment. LIQUIDATOR FOR BANKS, Receivers, Creditors' Committees, Estates.
HENRY K. FORT
2227 N. American Street, Philadelphia

WE ARE IN THE MARKET TO PURCHASE
complete power plants, D. C. and A. C. Motors, generators, transformers, and electrical instruments. Send us a list of what you have to offer. Let us have your inquiries on what you wish to purchase.
SUPERIOR ELECTRIC MACHINERY CO.
253 N. 3rd Street Philadelphia, Pa.

Watch—
the *Searchlight Section*
for
Equipment Opportunities

J. L. HEMPHILL & CO. Inc.

ELECTRICAL ENGINEERS AND EQUIPMENT
801 Williams St. North Bergen, N. J.

N. Y. C. Tel.: LOngacre 5-3227—N. J. Tel.: PAlisade 6-2600

MOTOR GENERATOR SETS

1—500-kw., 250-V., Westinghouse Synchronous motor Generator Set.
1—250-kw., 230-V., 3-ph., 60-cy., 2300-4600 Synchronous Motor Generator Set.
1—200-kw., 230-V., 3-ph., 60-cy., 2300-4100-V. Synchronous Motor Generator Set.
1—150-kw., 600-r.p.m., 250-V. Gen., 3-ph., 60-cy., 220-440-V. G.E. Synchronous Motor.
1—125-kw., 250-V., Westinghouse Synchronous Generator Motor Set 3-ph., 60-cy., 230-2200-V.
2—125-kw., 125-V., G. E. 2300-V. motor.
1—100-kw., 125-V., D.C., 220-440 A.C. G. E. Synchronous Motor Generator Set.
1—100-kw., 250-V., Gen., 900-r.p.m., 220-V. Synchronous Motor.
1—50-kw., 230-V., 1200-r.p.m., 220-V. Westinghouse Synchronous Motor.

ENGINE GENERATOR SETS

2—200-kva. 220/440/600/2300-V. General Electric Ames Uniflow.

TURBINES

1—1500-kva., 3-ph, 60-cy., 2300-V., Condens. West.
1—750-kw., 3-ph., 60-cy., 480-V., Non-Condens., West.
1—475-kva. Westinghouse Non-Condens.

TRANSFORMERS

3—333 kva. Pittsburgh 7500/15000/230/460-v.
4—333-kva. Pittsburgh, 4100/110/220-V.
6—200-kva. G. E. 2400/120/240-V.
4—150-kva. Westinghouse, 2400/120/240-V.
3—100-kva. Westinghouse, 2400/120/240-V.

LOW VOLTAGE M-G SETS

5000 amp., Hanson Van Winkle, 15/30 v.
5000 amp., Hanson Van Winkle, 6/12 v.
5000 amp., Bogue, 6/12 v.
2000 amp., Bogue, 6 v.
2000 amp., Bogue, 20v

MOTORS—3 phase, 60 cycle

No.	Hp.	R.p.m.	Volts	Type
1	1000	400	Any Voltage,	sl. rg.
1	800	180	4000	Westghse. Syn.
1	500	150	2300	Elec. Mach. Syn.
1	500	900	440/4000	Westghse. Syn.
1	500	720	4100	G. E., sl. rg.
1	500	450	2200	G. E., sl. rg.
1	350	900	2200/4000	Wh. Syn.
1	250	600	2200/4000	G. E. syn.
1	250	600	440–2200	G. E. syn.
3	200	450	2300/4100	G. E., sl. rg.
2	200	600	440	G. E., sl. rg.
1	150	360	2300	Allis-Chal., Syn.
3	200	514	4150–2300	G. E. syn.
2	200	514	2300–4000	G. E., sl. rg.
2	150	1200	220/440	Westg., sl. rg.
1	150	900	2200	G. E. Syn.
2	150	514	2200	Westg., sl. rg.
1	150	1800	2200	West. sq. cg. mfr.

PUMP

1—4,000,000 gal. Water Pump Worthington engine.

FREQUENCY CHANGER

1—100-kw., 750-r.p m., General Electric.

Complete Line of A.C. and D.C. Motors and Generators

TURBO-GENERATOR SETS

5000 K.W. General Electric, Condensing, 3-phase, 60-cycle, 2300 volts, 200 lb. pressure, 500 deg. total temperature; 13.2 lb. per Kw./Hr. full load water rate; four bearing machine in excellent condition.

1500 K.W. Westinghouse, Condensing, 3-phase, 60-cycle, 2300 volts, 200 lb. pressure, 475 deg. total temperature. With nominal changes turbine suitable for 250 lb. pressure and 550 deg. total temperature. New 1924. Little used and like new.

1500 K.W. Westinghouse, Non-Condensing, 3-phase, 60-cycle, 2300 volts, 400 lb. pressure, 60 to 110 lbs. gauge back pressure. In service five months. New October, 1928.

750 K.W. Allis-Chalmers, Condensing, 3-phase, 60-cycle, 480 volts, 200 lb. pressure, 450 deg. total temperature. New, 1923. First class condition.

500 K.W. Allis-Chalmers, Non-Condensing, 3-phase, 60-cycle, 480 volts, 150 lb. pressure, 10 lbs. gauge back pressure. New 1923. Very little used.

500 K.W. Allis-Chalmers, Condensing, 3-phase, 60-cycle, 480 volts, 200 lb. pressure, 450 deg. total temperature. Installed 1924. Fine con.

GENERAL RAILWAY EQUIPMENT COMPANY
NATIONAL HEADQUARTERS FOR USED TURBO SETS
1334 Widener Bldg., Philadelphia, Pa. *Rittenhouse* 2311 2741 Book Bldg., Detroit, Mich. *Cadillac* 0989

RE-NU-BILT
BELYEA
MOTORS

TRANSFORMERS SPECIALS
SINGLE PHASE, 60-CY., O.I.S.C.

Make	Type	Voltage
4—1000 kva. G. E.	OC	66,000-13,200/2300
6—500 kva. West.	"	2400-120/240
3—500 kva. G. E.	H	13,200-2300/4000 Y.
12—333 kva. Packard	A	13,200-2300
3—200 kva. G. E.	A	13,200/6600-2400
3—150 kva. G. E.	H	2300-230/115
2—150 kva. G. E.	H	2300-230/460
21—100 kva. Packard	A	2300-230/115
3—75 kva. G. E.	H	2300-230/115
3—37 ½ kva. West.	S	2400-120/240

MOTORS
3 PH., 60 CY.

Hp.	Type	Speed
675	Al. Ch. syn.	900
600	G.E. sl. rg.	257
600	G.E. syn.	257
450/360	West.sl.rg.	875/700
400	West. sl. rg.	514
300	Al. Ch. sl. rg.	585
260	Al. Ch. syn.	720
200	West. sl. rg.	900
200	G.E. sl. rg.	900
200	G.E. syn.	900
150	West. sl. rg.	720
150	G.E. sl. rg.	1750
100	Al. Ch. sl. rg.	685
80	G.E. syn.	1200
75	G.E. sl. rg.	600
75	G.E. sl. rg.	900
60	G.E. sl. rg.	900
50	G.E. sl. rg.	1200
50	West. sl. rg.	1200

ENGINE GENER.
1-400 kva., Cr. Wh., 240 v., 3 ph. 60 cy., 120 r.p.m. to Hamilton Corliss Engine.

D. C. MOTORS
ADJ SPEED-230V

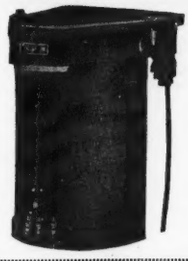
Hp.	Type	Speed
500/250	G.E.	500/375
100/200	G.E.	200/400
100	West.	365/600
80	Diehl	500/1100
75	West.	200/600
40	West.	300/900
35	El.Dy.	350/1050
27½	El.Dy.	450/1350
25	West.	400/1200
25	West.	650/2200
20	West.	375/1500
20	G.E.	650/1950
20	G.E.	500/1500
15	West.	400/1600
10/14	El.Dy.	300/1200
10	West.	500/1500
10	G.E.	600/1800

MOTOR GENER.
1-750 kw. G. E. MPC., 250 v., D.C. Gener. to 1100 hp. G. E., ATI, synch. motor, 2200-3-60-900 r.p.m.

Above are a few of our stock items.

BELYEA
COMPANY, INC.
143 WEST 18TH ST.
NEW YORK, N. Y.

TRANSFORMERS



A Complete Stock. **Prompt Shipment.**

3—667 KVA Gen. Electric Transformers, Type H, Form KSD, 60 cycle, 4254/7370Y-230/115 volts, very late type. **$1100.00 EACH**

We Rewind, Repair and Redesign all Makes and Sizes.
ALL TRANSFORMERS GUARANTEED FOR ONE YEAR

Write for Catalog No. 129-F

THE ELECTRIC SERVICE CO., INC.
"AMERICA'S USED TRANSFORMER CLEARING HOUSE"
STATION M CINCINNATI, OHIO

M. J. HUNT'S SONS
Delaware Ave. & Berks, Philadelphia, Penna.

Offer From Stock:

50 —— A.S.M.E. BOILERS —— 50
100 ——— TANKS ——— 100
(Pressure & Storage)
50 ——— PUMPS ——— 50
(Electric & Steam)

Automatic & Unaflow Engine Generator Sets, Motors, Feed Water Heaters, Smoke - Stacks, Air Compressors, Valves, etc.

● SEND FOR NEW LISTING ●

New and Used Equipment

Recently released from service by a number of electric and gas utility companies

POWER PLANT EQUIPMENT
Turbo Generators
Engine Generator Sets
Frequency Changers
Motor Generator Sets
Motors and Generators
Boilers and Condensers
Rotary Converters

CONSTRUCTION EQUIPMENT
Compressed Air Tools
Derricks, Cranes, Hoists
Concrete Mixers
Flat Cars, Dump Cars

SUBSTATION EQUIPMENT
Transformers
Switchboards and Oil Circuit Breakers

TRANSMISSION LINE MATERIALS
Poles and Cross Arms
Transformers
Lightning Arresters
Wire and Cable
Insulators
Line Hardware

● **APPARATUS EXCHANGE** ●

ELECTRIC BOND AND SHARE CO., TWO RECTOR ST., NEW YORK, N. Y.

FOR SALE

Turbo Generator Sets

3—4000 kw., 3 ph., 60 cy., 2300 v. Gen. Elec. 3600 r.p.m. condensing, 200 lb., 125 deg. superheat.
2—750 kw., 3 ph., 60 cy., 2300 v. Gen. Elec. 3600 r.p.m. condensing, 135/-199 lb., 499 deg. total temp.
6—B & W Boilers, 4—600 hp., 2—665 hp., 225 lb. St. Superheaters, Soot blowers, Stokers, etc.

All installed new, 1920-1923
FOR PARTICULARS APPLY

JOHN D. CRAWBUCK COMPANY
EMPIRE BLDG., PITTSBURGH, PA.

ENGINE SETS (A.C.)

1000 kva. Burke—Erie Ball, 4 v.
625 kva. Al. Chal.—Al. Chal. Corliss
430 kva. Ridgway — Ridgway, 4 v.
400 kva. G.E.—Ames Uniflow
400 kva. C.W.—Hamilton Corliss
250 kva. G.E.—Murry Corliss
250 kva. Al. Chal. — Al. Chal. Corliss
250 kva. G.E.—Skinner Uniflow
180 kva. G.E.—Chuse Uniflow
175 kva. (2) G.E.—Ames Uniflow
150 kva. (2) Al. Chal.—Chuse Uniflow
120 kva. (2) G.E.—Ames Uniflow
90 kva. G.E.—Chuse Uniflow
60 kva. G.E.—Erie Ball
50 kva. G.E.—Harrisburg

TURBINES (A.C.)

1875 kva. G.E. (Mixed Pres.)
1700 kva. Wghse. (Cond.)
1563 kva. G.E. (Cond.)
1250 kva. Wghse (Bleeder)
937 kva. Al. Chal. (Mixed Pres.)
937 kva. G.E. (Cond.)
625 kva. Wghse. (Bleeder)
625 kva. Wghse. (Cond.)
625 kva. Al. Chal. 300 lbs. Pres.
625 kva. G.E. (Non. Cond.)
375 kva. Wghse. (Mixed Pres.)
250 kva. G.E. (Non. Cond.)
187 kva. Wghse. (Cond.)
125 kva. G.E. (Non. Cond.)

BOILERS (A.S.ME.)

800 hp. (2) EdgeMoor 300 lbs. Cr. drum
605 hp. Springfield 165 lbs.
512 hp. Springfield 225 lbs. Cr. drum
500 hp. (2) Sterling 200 lbs.
508 hp. Kingsford Web. 200 lbs.
407 hp. (3) EdgeMoor 200 lbs.
400 hp. Wicks 160 lbs. Cr. drum
300 hp. B. & W. 175 lbs. Marine Type
200 hp. (2) Heine 160 lbs.

M. G. SETS

500 kw. Wghse. 250 v.—Syn. Motor 4000/2300 v.
500 kw. (2) Ridg. 250 v.—Ridg. 440 v.

ENGINE SETS (D.C.)

1000 kw. Al. Chal. 250 v.—Al. Chal. Cor.
500 kw. G.E. 250 v.—Erie Ball 4 v.
300 kw. G.E. 250 v.—Turbine
250 kw. Ridg. 250 v.—Harrisburg Uniflow
250 kw. Wghse. 250 v.—Erie Ball 4 v.
200 kw. G.E. 125 v.—Skinner Uniflow
150 kw. G.E. 125 v.—Harrisburg Uniflow
125 kw. G.E. 250 v.—Erie Ball 4 v.

Power Plant Equipment Co., Inc., 39-41 Cortlandt St., New York City, N. Y.

SPECIAL OFFERINGS for December in

Rebuilt Guaranteed Electrical Equipment

MOTORS

1—100 h.p. West., Type C.W., Slip Ring, 720 R.P.M.
1— 75 h.p. G.E., Type M.T., Slip Ring, 1170 R.P.M.
1— 50 h.p. Western Electric, Slip Ring, 900 R.P.M.
1— 50 h.p. Westg. D.C., S.K. Type, 1150 R.P.M.
10— ½ h.p. Wagner Synchronous, 1800 R.P.M.

Above items constitute only a part of our complete stock. Write for Stock List.

WILLIAM H. LUDWIG
656 Bushwick Ave., Brooklyn, New York

Turbo Generator Sets

1—2500 Kw. Westinghouse 3-60-2300 V.
1—1500 Kw. Gen. Elec. 3-60-2300 V.
1—1000 Kw. Gen. Elec. 3-60-600 V.
2— 500 Kw. Gen. Elec. 3-60-2300 V.
1— 300 Kw. G.E. (Non Cond.) 3-60-600 V.

Boilers

604 Hp. B.&W. A.S.M.E. 200 lbs.
400 Hp. B.&W. A.S.M.E. 200 lbs.
300 Hp. B.&W. Mass. Std. 160 lbs.
2—275 Hp. H.R.T. Mass. Std. 153 lbs. (1925).

Air Compressors

Belted—Direct Driven—Steam

2—173 Ft. Chgo. Pneu. (9x8).
2—340 Ft. Chgo. Pneu. (12x10)—100 lbs.
1—888 Ft. I.R. (Imp. 10)—100 lbs.
1—789 Ft. IR X4—55 lbs. (steam).
1—1531 Ft. I.R. XPV 100 lbs. (steam).

Engine Generators

1—250 Kw. 3-60-550 V. G.E. to 300 Hp. Buckeye Eng. (Piston Valve) 8 Yrs.
2—150 Kw. 3-60-550 V. G.E. to 200 Hp. Buckeye Eng. (Piston Valve) 8 Yrs.

Also Engine Sets, Motor Generators and Complete Power Plant Equipment

A. LEE ELLIS, 50 High St., Boston, Mass.

"The Buyer Must Be Satisfied Always"

FOR SALE

We have the following items from a building which we are dismantling for the government at Washington, D. C.

7 only Yarrow Boilers—500 hp. factory rating.
2 only Heine Boilers—150 hp. factory rating.
2 only Kewanee Boilers—100 hp. factory rating.

All of these boilers are oil burning equipment, and all are in excellent condition.

Inquiries will receive our prompt attention.

NEWMAN WRECKING CO., INC.
1963 West 3rd Street, Cleveland, Ohio

ASME BOILERS

1—400 H.P. Edge Moor water tube, 200 lbs.
2—400 H.P. B & W water tube, 200 lbs.
1—300 H.P. Edge Moor water tube, 200 lbs.
2—150 H.P. Erie Economic, 125 lbs.
2—100 H.P. Locomotive, 125 lbs.

THE O'BRIEN MACHINERY CO.
113 N. 3rd St., Philadelphia, Pa.

4—A.C. Engine Generator Sets: 125, 150, 300 and 400 Kw.
2—Synchronous Motors: 200 Hp. and 300 Hp.
1—400 Kva. Transformer.
2—18x16 Worthington Air Compressors, with or without motors.

MERTES MACHINERY CO.
Milwaukee, Wisconsin

FOR SALE

Turbo-Generators; Engine-Generators; both A.C. and D.C.; Motor-Generators; Air-Compressors; Boilers; Motors, etc.

Selected by Engineers—reconditioned consultation manufacturers. Advise any apparatus or equipment you have for liquidation.

STEPHEN A. DOUGLASS CO.
562 West 186th Street, New York City

MOTORS

3—G.E. Induction, Type KT 352—3 phase. 60 cy., 440 V., 60 Hp., with Pulleys. Bases, Starting Compensators, Push Button Switches.

Excellent condition. Best offer will buy.

FS-395, Power
330 West 42d St., New York City

Engine and Turbo Units

200 kw., 250 v. Cr.-Wh.—Erie Ball 4 valve.
150 kw., 250 v. Cr.-Wh.—Harrisburg Uniflow.
3—4000 kw. G. E.-Curtis, 200 lb. pressure, complete.
6—600 hp. B. & W., 225 lb. with superheaters.

MOOREHEAD-REITMEYER CO.
Columbia Bldg., Pittsburgh, Pa.

BOILERS

350-hp. scotch marine boiler dry back 150 lbs.
3—400-hp. B. & W. Sterling Boilers, 200 lbs. with stokers.
150-hp, Kewanee smokeless type.

Also Other Types and Sizes

THE ACME EQUIPMENT COMPANY, Inc.
310 C. P. A. Building, Detroit, Michigan

SEARCHLIGHT SERVICE

Covers the Advertising of

Agencies Wanted
Agents Wanted
Auction Notices
Bids Wanted
Books and Periodicals
Buildings for Sale
Business Opportunities
Civil Service Opportunities
Contracts to Be Let
Contracts Wanted
Educational
Employment Agencies
Foreign Business
For Exchange
For Rent
Franchises
Labor Bureaus
Machinery Wanted
Partners Wanted
Patent Attorneys
Patents for Sale
Plants for Sale
Positions Vacant
Positions Wanted
Property for Sale
Proposals
Receivers Sales
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Second Hand Equipment
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Specialties
Tutoring
Miscellaneous For Sale. For Rent and Wanted

Address
Departmental Advertising Staff
McGraw-Hill Publications
330 West 42d Street, New York

ELECTRIC LOCOMOTIVES

SWITCHING BATTERY TYPES

1—15-ton Westinghouse, standard gauge.
1—10-ton Atlas, standard gauge.

WALLACE E. KIRK COMPANY
Grant Building, Pittsburgh, Pa.

ROTARY CONVERTER

500 kw. Westinghouse, 3 phase, 60 cycle generator end, 600 volts, D.C. Automatic switching.

Engine Generator Sets, Steam Engines, Air Compressors, Boilers.

HYMAN-MICHAELS COMPANY
20 N. Wacker Dr. Bldg., Chicago
By. Exchg. Bldg. St. Louis, Mo. — 101 West 31st St. New York City

---

—DIESEL BARGAIN—

50 hp. Fairbanks-Morse Type Y Vertical connected to 32 kw., 3/60/2300 volt generator. Complete. Fine shape throughout. Low price, with or without generator, if sold from present foundations.

C. H. WEHNER
509 Locust St., St. Louis, Mo.

VOLTAGE REGULATORS

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100 hp. Westgh., 870 r.p.m.
100 hp. G.E., sl.rg., 1200 r.p.m.
100 hp. G.E., sl.rg., 865 r.p.m.
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150	2200–220–440	G.E.	720
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100	2200–440–220	Westghse.	1200
100	550	Wagner	720
100	2200–550	Westghse.	900
100	440–220	G.E.	720
100	550	G.E.	900
100	220–440	G.E.	900
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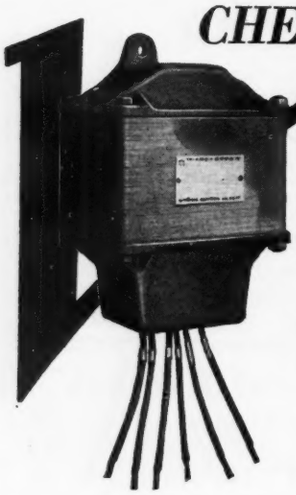

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√ *Small drills*
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it is Sensitive

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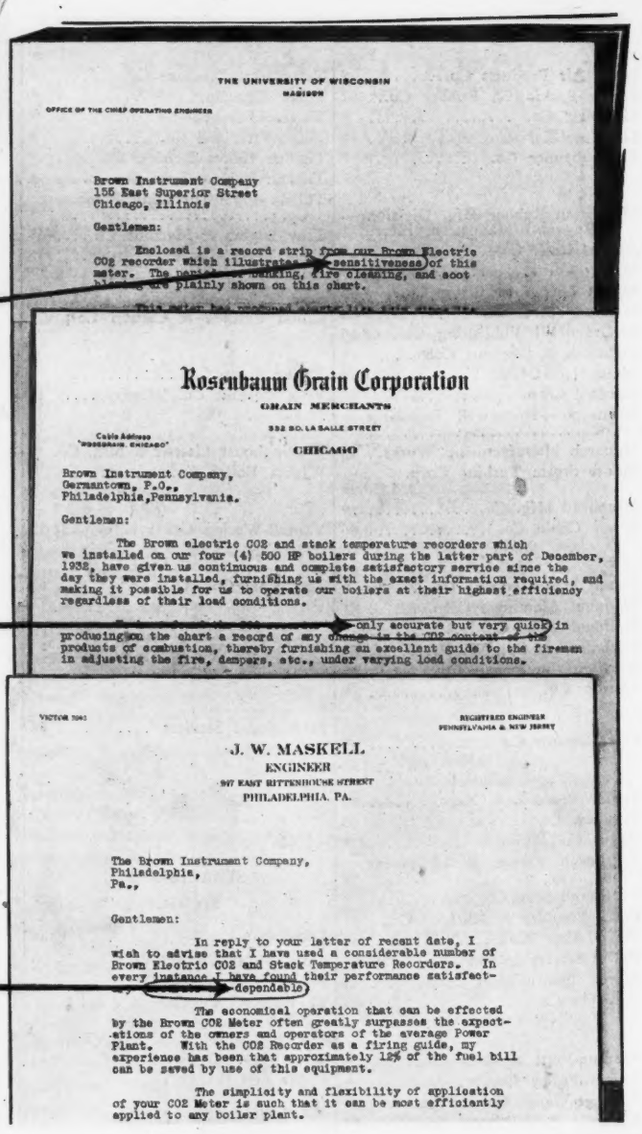
"We have found the CO_2 Recorder not only *accurate* but very quick in producing on the chart a record of any change in the CO_2 content of the products of combustion, thereby furnishing an exceilent guide to the fireman in adjusting the fire, dampers, etc., under varying load conditions."

it is Dependable

"I wish to advise that I have used a considerable number of Brown Electric CO_2 and Stack Temperature Recorders. In every instance, I have found their performance satisfactory, accurate and *dependable*."



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MADISON
OFFICE OF THE CHIEF OPERATING ENGINEER

Brown Instrument Company
156 East Superior Street
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Enclosed is a record strip from our Brown Electric CO2 recorder which illustrates the sensitiveness of this meter. The periods of banking, fire cleaning, and soot blowing are plainly shown on this chart.

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GRAIN MERCHANTS
332 SO. LA SALLE STREET
Cable Address "ROSEGRAIN, CHICAGO"
CHICAGO

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... only accurate but very quick in producing on the chart a record of any change in the CO2 content of the products of combustion, thereby furnishing an excellent guide to the firemen in adjusting the fire, dampers, etc., under varying load conditions.

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Pa.,

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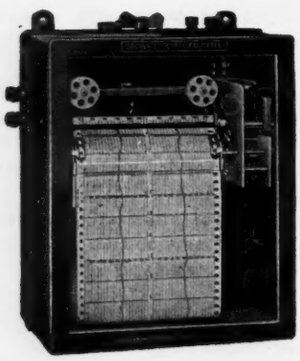
The simplicity and flexibility of application of your CO2 Meter is such that it can be most efficiently applied to any boiler plant.

They Have Reduced Fuel Costs



POWER Plants with fuel bills ranging from $5,000 to $50,000 yearly have reduced those fuel bills 10% to 20% — Similar savings can be made in your plant — by giving your fireman continuous records of per cent CO_2 in flue gases to use as a firing guide. For per cent CO_2 is the recognized measure of combustion efficiency. Accurate records of per cent (%) CO_2 enable your fireman to maintain maximum efficiency — which results in substantial fuel savings. That is why engineers in hundreds of plants express 100% satisfaction with Brown CO_2 Meters.

Write for information and Catalog No. 3004.

THE BROWN INSTRUMENT COMPANY
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Brown Electric CO_2 Meter

to measure is to economize